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Report 204

Geology of

McFadden and Rattray Townships

District of Timiskaming

By

Z.L. Madill

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GEOLOGICAL MAP

(back pocket)

Map 2445 (coloured)–McFadden and Rattray Townships,
District of Timiskaming.
Scale 1:31 680 or 1 inch to ½ mile.

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(back pocket)
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ABSTRACT

This geological report describes the mineral exploration history, bedrock formations, structure, and geological evolution of McFadden and Rattray Townships which comprise a 160 km² north-south rectangular area situated east of Kirkland Lake along the Ontario-Quebec border.

Poorly exposed narrow belts of Early Precambrian (Archean) metamorphic and intrusive assemblages occur in the west-central, southeastern, and southern parts of the map-area. Gently dipping Middle Precambrian (Huronian) rocks of very low metamorphic grade, cover more than three-quarters of the area, and overlie the Archean complex with great angular unconformity. A few east-northeast-trending Late Precambrian diabase dikes intrude the older formations.

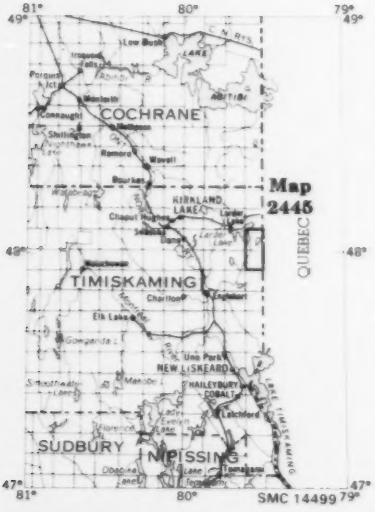

Figure 1–Key map showing location of McFadden-Rattray Area.
Scale 1:3 168 000 (1 inch to 50 miles).

The oldest formation consists of Early Precambrian (Pontiac Group) fine-grained metawacke schists and gneisses which have been extensively migmatized in the southeastern part of the map-area by *lit-par-lit* injections of an Early Precambrian granitic batholith which extends into Quebec. South of Larder Lake, a complex arcuate fold belt consists of metavolcanic and associated intercalated to unconformable metasedimentary sequences. These rocks were derived from a waning calc-alkalic felsic volcanic cycle related to the Skead Group that commenced with a cycle made up of a juvenile komatiitic trend represented by ultramafic to mafic volcanic rocks and associated intrusive bodies. Later differentiated intrusions of ultramafic to felsic alkalic rocks have invaded and altered the volcanic and sedimentary rocks.

Middle Precambrian rocks of the Coleman Member, subdivided on the basis of envirogenetic criteria consist of; a lower intercalated rhythmite-turbidite facies of glacio-fluvio-lacustrine deltaic association, a middle assemblage of glacial diamictite facies, and an upper unit of fluvio-eolian association. The deposition and character of Coleman rocks was conditioned by climate and tectonic parameters which included epeirogenic source area uplifts and structural confinement of sedimentation to a rifted fiord-like trough.

The unfolded Coleman strata subtly reflect the topography of the underlying basement complex and have been affected by north-northeast and northwest-striking faults which have combined with isostatic adjustments to form prominent scarps. The Early Precambrian assemblage has a complex structure that results from several phases of folding, faulting, and intrusion, but in general, the rocks strike north-south and face east with steep dips.

The area lies in a gold mining district. Relatively low values of this metal as well as occurrences of copper, lead, zinc, and silver have been reported. Continued exploration for gold and base metals is recommended both in the exposed west-central Archean fold belt and in the basement complex underlying the Coleman Member.

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

If the reader wishes to convert imperial units to SI (metric) units or SI units to imperial units the following multipliers should be used:

CONVERSION FROM SI TO IMPERIAL			CONVERSION FROM IMPERIAL TO SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy)/ton (short)	20.0	pennyweights/ton (short)
1 pennyweight/ton (short)	0.05	ounce (troy)/ton (short)

NOTE–Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries published by The Mining Association of Canada in co-operation with the Coal Association of Canada.

Geology of the McFadden and Rattray Townships Area

District of Timiskaming

by

Z.L. Mandziuk[1]

INTRODUCTION

Geological studies and mapping at a scale of 1:15 840 were completed during the 1978 field season over an area comprising and immediately adjacent to McFadden and Rattray Townships. The map-area, situated along the Ontario-Quebec interprovincial boundary line, is centred 14 km southeast of the town of Larder Lake and includes areas delimited by Latitudes 47°55′30″ to 48°06′00″ and Longitudes 79°31′00″ to 79°38′00″, an area of approximately 160 km^2. Geological investigation of this area forms an integral component of a regional stratigraphic-structural synthesis of the Abitibi Belt in the Kirkland-Larder Lakes area by L.S. Jensen (1977), and is of relevance to current strato-facies studies of Huronian sedimentary rocks comprising northern elements of the Cobalt Embayment by J. Wood (1978).

Access

Eastern parts of the map-area are readily accessible by driving east from the settlements of Kirkland Lake or Larder Lake along Highway 66 and then south along the interprovincial boundary road. Road access to extensive old logging trails in the southern sector of Rattray Township is possible along secondary roads extending eastwards from the Englehart-Larder Lake road, Highway 624. Western and central parts of the area can be reached by motor boat from Larder Lake and by canoe and portage from Raven Lake downstream to Corset and Ward Lakes and the Larder River. Numerous unmaintained old

[1]Geologist, Precambrian Section, Ontario Geological Survey, Toronto. Manuscript approved for publication by the Chief Geologist, March 30, 1979.
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to recent trails and logging roads of variable surface condition occur throughout the area, and some are indicated on the accompanying geological map (Map 2445, back pocket).

Mineral Exploration

Widespread prospecting activity was stimulated by the discovery of rich silver ores at Cobalt in 1903, and this eventually led to an important gold find near the northeast arm of Larder Lake in August 1906 and initiated the Larder Lake gold rush (Savage 1964, p.1). The original discovery was further explored, and eventually became the major gold-producing Kerr-Addison Mine at Chesterville in 1936; the site being situated approximately 4.3 km north of McFadden Township. Many of the old pits, trenches, and diamond-drill holes which occur in the map-area are often in abundant erratically distributed pyritiferous quartz-vein systems of variable continuity and dimensions, and attest to the early unrecorded exploration for gold in the vicinity of known occurrences along the favourable Larder Lake - Cadillac Fault Zone.

Data filed at the Kirkland Lake Resident Geologist's Office indicate that the first recorded mineral exploration in the map-area was carried out for gold by Lucky Girl Mines Limited. In 1947, this company put down four diamond-drill holes at the south and west ends of Island CC on Larder Lake, and single holes on the southern and eastern shores of the lake. In 1948, P. Wojcieszyn conducted further exploratory diamond drilling for gold on Island CC. In 1951-52 and 1968, E. Lipasti diamond drilled several sites on the east and west sides of Big Pete Island in Larder Lake to assess the economic potential of small intrastratal volcanogenic sulphide mineral occurrences. Diamond drilling of five holes performed by Kerr-Addison Mines Limited in 1956 explored a showing of copper mineralization on the west side of Ice Fish Lake in Rattray Township. More recently, in 1976, Geophysical Engineering Limited contracted airborne magnetometer and electromagnetometer surveys which included coverage of the northwest corner of McFadden Township; and in 1977, Colex Explorations Incorporated conducted airborne magnetometer and electromagnetometer surveys over the west-central parts of the area and ground magnetometer, electromagnetic, and soil geochemical surveys over Big Pete Island, Island CC, and adjacent lake areas. Additional information on exploration work in the map-area is given in the section "Descriptions of Properties".

Geophysical and geochemical anomalies have been detected. Indications of low grade gold, copper, silver, and lead-zinc mineralization have been detected in some of the drill cores, but to date no favourable results have been found which would encourage any further development work. Approximately 50 active mineral exploration claims, however, are held and the possibility of ore mineralization has not been ruled out for a large part of the area.

OGS 10 220

Photo 1–View looking south towards map-area, ridges of Huronian rock fan out from Raven Mountain in the foreground.

Topography and Natural Resources

Geomorphic features in the map-area are mostly determined by the physical properties and structure of the underlying lithologic units. The oldest rocks in the area comprise an Early Precambrian fold complex of metavolcanics, metasediments, and intrusive rocks which display physiographic features typical of the intensely glaciated Precambrian terrain of the Abitibi Uplands. Folded Early Precambrian rocks form two large islands in Larder Lake and underlie low lying swampy areas to the south of the lake. Locally, more resistant diabase-gabbro, diorite, and granite form small rugged and rocky ridges, cliffs, and rounded knobs within the complex, but the relief is generally less than 50 m. Most areas underlain by Early Precambrian rocks present a swampy, monotonous, low, rolling surface covered with small rounded outcrops and thin discontinous deposits of sand and gravel or varved clays of the Late Wisconsinan glacial Lake Barlow-Ojibway.

More than three-quarters of the map-area are underlain by Coleman Member sedimentary rocks of the Middle Precambrian Gowganda Formation. Flat-lying to gently-dipping resistant strata composed of very well indurated quartzose sedimentary rocks form prominent and impressive north-northeast trend-

ing ridges made up of mesas and cuestas bounded by steep terraced rock bluffs which rise some 50 to 230 m above the level of Larder and Raven Lakes (Photo 1). In contrast, some parts of the basal units of the Coleman Member underlie low-lying, well drained, flat forested areas covered with thin deposits of clay-silt or sandy till. In Rattray Township, the Coleman strata have been diagenetically compacted over a basement depression to form a shallow perched cuesta-type basin which has been filled in with Pleistocene glaciolacustrine clay and silt. Kames, kame terraces, and crevasse fillings occur on and along the Coleman Member ridges. The major north-northeast trending Boundary Esker accounts for extensive deposits of sand and gravel along a low ridge west of the Boundary Road in McFadden Township and the occurrences of esker deposits in Rattray Township.

The map-area lies south of the height of land and drains southwards via the Larder River system, which consists of fault-controlled linear lake basins, into Lake Timiskaming. Faults and lineaments exert control on local drainage patterns in the map-area, and account for many of the prominent scarps of Coleman rocks.

A thick mixed forest cover occurs throughout most of the drift-covered areas, and is mostly composed of poplar, birch, jack pine, white pine, black spruce, cedar, balsam, and occasional red pine and tamarack. Cedar and black spruce usually occur in low or flat, poorly drained areas where sedges and sphagnum mosses commonly develop over shallow peaty organic soil. Jack pine predominates on well-drained sorted drift. Rattray Township has been extensively lumbered in the south, and recent cutting has occurred in the northeast sector of the township.

Moose, black bear, red deer, beaver, martin, fox, rabbit, and numerous species of [illegible] occur in the area, and the larger lakes contain thriving populations of pike, bass, pickerel, perch, and lake trout. A well-traversed canoe route between Raven and Larder Lakes, a ski club at Raven Mountain, boating, fishing, and rock climbing make up the recreational resources within and near the map-area.

Geological Surveys

The first published geological survey to include parts of the map-area was conducted by M.F. Wilson (1912) who comprehensively investigated the geology and economic resources of the Larder Lake district and adjoining areas in Quebec at a scale of 1:126 720. P.E. Hopkins (1924) surveyed parts of McFadden Township at a scale of 1:47 520 and J.E. Thomson (1947) mapped a western part of McFadden Township at a scale of 1:12 000. Because the focus of attention in the past had concentrated on lithologies hosting Early Precambrian gold deposits, the area mostly underlain by Middle Precambrian Huronian rocks had not been previously investigated in detail. The current geological survey was conducted on a base-map scale of 1:15 840 with routine pace and compass traverses used to tie-in outcrop locations to topographic features recognizable on air photos.

Acknowledgments

J.G. Patterson, senior assistant to the author, was responsible for about 40 percent of the mapping and as well as junior assistants, C. Batchelor, G. Barton, and D. Oneschuk, provided competent traverse support and aided the author with other stratigraphic and interpretive investigations during the 1978 field season.

The author gratefully acknowledges aid in the form of descriptive and conceptual knowledge imparted to him by geologists H.L. Lovell, L.S. Jensen, F.R. Ploeger, and John Wood of the Ontario Geological Survey.

GENERAL GEOLOGY

The map-area lies at the boundary between the south-central part of the Superior Province and the Cobalt Embayment of the Southern Province, some 130 km north of the Grenville Front. Bedrock formations consist chiefly of Early Precambrian (Archean) metavolcanics, metasediments, and plutonic rocks, and Middle Precambrian (Huronian) sedimentary rocks (Table 1). These rocks belong respectively to the Abitibi Belt and the Cobalt Plate (or Embayment) structural subprovinces, and are separated by a profound angular unconformity. Small isolated occurrences of east-northeast-trending mafic intrusive rocks have been classified as Late Precambrian (Keweenawan). Pleistocene deposits composed of lodgement and ablation till, sand and gravel, varved lacustrine clays, and esker sand, as well as Recent deposits of muskeg and alluvium, constitute the surficial deposits overlying the bedrock. Table 1 summarizes the lithostratigraphic classification scheme for the consolidated rock formations occurring in the map-area and conforms closely with previously published descriptions of the regional stratigraphy in the Kirkland and Larder Lakes area. A three-fold division into Early, Middle, and Late Precambrian defines the time-stratigraphic limits of the formations encountered, though individual members within an age group do not necessarily succeed one another in a strict time-stratigraphic sense.

The Early Precambrian metavolcanic sequence consists of structurally complex, interlayered or successive, massive, and pillowed, mafic to ultramafic lava flows. These rocks occasionally grade into coarser differentiated mafic to ultramafic rocks which are massive and often serpentine-bearing or pyroxenitic. Interbeds of derived proximal fine-grained to coarse-grained metasediments and mudflows display complex and structurally obscured spatial relationships with their source rocks. A few thin bands of felsic metavolcanics occur within the flow piles. On Island CC a distinctive pyroclastic volcanic breccia is intimately mixed with coarse poorly sorted conglomerate. The metavolcanic sequence is unconformably overlain by, and partly interbedded with, (pre-Timiskaming) metasediments consisting of steeply dipping wacke, siltstone, slate, argillite and minor conglomeratic lenses. In southern Rattray Township, small inliers of Pontiac-type metasediments such as those which occur in Pense and Brethour Townships to the south (Lovell 1977), consist of quartz-feldspar-biot-

TABLE 1 | TABLE OF LITHOLOGIC UNITS FOR THE McFADDEN-RATTRAY TOWNSHIPS AREA.

PHANEROZOIC

CENOZOIC

QUATERNARY

Swamp peat, lacustrine clay and silt, stream sand and gravel, lodgement and ablation till, esker sand and gravel, varved glaciolacustrine clay and silt.

Unconformity

PRECAMBRIAN

LATE PRECAMBRIAN

MAFIC INTRUSIVE ROCKS (KEWEENAWAN)

Augite diabase, olivine diabase, differentiated diabasic rock, lamprophyre.

Intrusive Contact

MIDDLE PRECAMBRIAN

HURONIAN SUPERGROUP

COBALT GROUP

GOWGANDA FORMATION

COLEMAN MEMBER

Arenite lithosome: light-grey to green massive feldspathic arenite, quartzose arenite intercalated with pink arkose pebble conglomerate, minor argillite.

Diamictite lithosome: blue-grey sparkling saccharoidal paraconglomerate intergraded with pebbly argillite, arkose, feldspathic wacke, minor orthoconglomerate.

Parallel Unconformity (Disconformity)

Rhythmite-turbidite lithosome: dull grey to sparkling blue-grey laminated or massive argillite-wacke; layered, massive, and graded arkose and wacke; dropped clasts.

Unconformity

EARLY PRECAMBRIAN

FELSIC INTRUSIVE ROCKS (ALGOMAN)

Granitic rocks, syenitic rocks

Intrusive Contact

INTERMEDIATE TO ULTRAMAFIC INTRUSIVE ROCKS

Differentiated syenite, lamprophyre, gabbro, diorite, lesser pyoxenite.

Intrusive Contact

METAVOLCANICS (KEEWATIN TYPE) AND METASEDIMENTS

UPPER METASEDIMENTS

Feldspathic wacke, argillite, minor slate, and arkosic conglomerate.

ULTRAMAFIC AND MAFIC METAVOLCANICS (PICHÉ GROUP?)

THOLEIITES

Dark green to black iron-rich tholeiitic basalt, medium grey to green magnesium-rich tholeiitic basalt consisting of fine-grained massive flows, pillow flows, pillow breccia, flow breccia, tuff-breccia, variolitic flows, and gabbroic and diabasic textured flows.

KOMATIITES

Dark green, black or light grey ultramafic komatiite and basaltic komatiite consisting of massive and pillowed flows, pyroxenitic-textured flow interiors, serpentinite.

FELSIC METAVOLCANICS (SKEAD GROUP)

Light yellow to buff or pink to light green rhyolite-dacite massive calc-alkalic flows. alloclastic volcanic breccia, tuff-breccia, cherty tuff, minor sulfide interflow; intrusive equivalents.

Unconformity

LOWER METASEDIMENTS (PONTIAC GROUP)

Quartz-feldspar-biotite-amphibole schist, feldspathic wacke, slate.

---

ite-amphibole schist with lesser intercalated and fragmented black slaty beds. Further east towards the Quebec border, the Early Precambrian Pontiac-type metasediments become more metamorphosed and gneissic in the vicinity of a wide *lit-par-lit* contact zone with Early Precambrian Algoman-type felsic intrusive rocks comprising a large granitic batholith or massif (Chagnon 1968; Wilson 1912). On the west side of the map-area, another Early Precambrian intrusive body composed of differentiated syenite reintruded by a later granite cuts through the previously described metavolcanics and metasediments. Small sills, dikes, and irregular shaped intrusions of vari-textured mafic syenite, gabbro, diorite, and lamprophyre of uncertain age relationships are also present in the rocks.

More than 75 percent of the map-area is underlain by a substantial thickness of Middle Precambrian Coleman Member sedimentary rocks which unconformably overlie the Early Precambrian. The Coleman Member comprises the lowest unit in the Gowganda Formation of the Cobalt Group (see Table 1). These flat-lying to gently dipping, low grade to unmetamorphosed epiclastic rocks outcrop along a prominent series of north- to northeast-trending ridges made up of buttes, mesas, and cuestas bounded by steep terraced bluffs and fault scarps. The linear system of ridges are erosional remnants of extensive and thick deposits of sediment laid down in an elongate steep-sided trough interpreted by the author to be a zeugogeosyncline (Kay 1951), or a block-faulted rift structure marginal to an intracratonic autogeosynclinal depression lying to the south (the Cobalt Embayment). The lowest exposed parts of Coleman Member rocks mostly consist of generally thinly bedded to laminated rhythmic sequences of glacio-lacustrine argillite-wacke with dropped clasts intercalated with massive, crossbedded and graded fluvio-deltaic rocks of arkosic compositions. Sedimentary structures including current bedding, ripple marks, mud cracks, and sole marks are well developed. Argillaceous units tend to increase in volume up the section to the level where a disconformity is reached. Above

this disconformity, there occurs a massive to crudely stratified heterogeneous assemblage of vertically and laterally intergraded facies deposited under conditions of tectonic instability. The most abundant rock type above the disconformity is a very poorly sorted to nonsorted, polymictic, matrix-supported paraconglomerate with predominantly felsic intrusive pebble to cobble size clasts and fewer metavolcanic and metasedimentary fragments derived from Early Precambrian rocks which outcrop in northerly terrains. The volume percentage of clasts is generally less than 15 percent, and often less than 5 percent, and most of the rock is a tillite-like diamictite with a well indurated matrix of poorly sorted fine sand, rock flour, or mud-silt which is subarkosic to lithic and occasionally crudely bedded. Intercalated and intergraded with the paraconglomerate are lesser volumes of irregularly distributed argillite-wacke and arkosic rocks with occasional clast-supported framework orthoconglomeratic lenses. Compositional and textural maturity and degree of sorting generally increase in the upper levels of the exposed Middle Precambrian section where occurrences of light grey and green medium- to fine-grained massive quartzofeldspathic arenites were observed.

EARLY PRECAMBRIAN COMPLEX (ARCHEAN)

Early Precambrian rocks are of limited areal extent within the map-area and occur mainly on the large islands in the south of Larder Lake and along a narrow 2 km wide belt which occurs in low-lying largely drift covered areas to the south of the lake. In southern Rattray Township, small inliers of Early Precambrian Pontiac-type metasediments (*see* Lower Metasediments, Table 1) are in gradational contact to the east with a large granitic batholith. L.S. Jensen (1978) has recognized a cyclic pattern of subalkalic to alkalic volcanism, plutonism, and related sedimentation which is preserved in a large east-plunging synclinorium in the Kirkland-Larder Lake area and has defined several rock stratigraphic units composed of intrusive and layered metavolcanic-metasedimentary assemblages. The current map-area, occupying an arcuate fold part of the south limb of the synclinorium, contains a metavolcanic-metasedimentary sequence which represents the waning phases of the Skead Group (Jensen 1978; Ridler 1970) volcanic cycle. This cycle is conformably to disconformably overlain by, and in part intermingled with, rock types of a succeeding unnamed cycle possibly correlative to the Piché Group in Quebec (H.L. Lovell, Resident Geologist, Ontario Ministry of Natural Resources, Kirkland Lake, personal communication 1978). Small occurrences of massive and fragmental calc-alkalic metavolcanics of rhyolitic to dacitic composition display lithologic affinities with the upper Skead Group and are made up of lithologic types which include massive flows, cherty tuff, tuff-breccia, and coarse alloclastic to pyroclastic volcanic breccia.

Metavolcanics comprising the succeeding layered assemblages of the unnamed group are composed of structurally complex, interlayered or successive, massive, and pillowed ultramafic and basaltic flows of a komatiitic suite which is succeeded by magnesium-rich and iron-rich basalt flows, and fragmental rocks of a tholeiitic suite.

The mafic to ultramafic metavolcanics occasionally grade into coarser differentiated subalkalic sills and plugs of massive pyroxenitic, gabbroic, and dioritic rocks which are often serpentine-bearing and probably represent intrusive equivalents and feeders.

In general, the Skead Group related calc-alkaline felsic metavolcanics occur as a few thin conformable bands randomly distributed within the thick flow piles of the unnamed group; however, a unique unit of the felsic metavolcanics occurs on Island CC where a distinctive alloclastic-pyroclastic volcanic breccia is intimately mixed with coarse poorly sorted conglomerate.

The mafic to ultramafic volcanic rocks of the unnamed group are frequently metamorphosed and sheared to talc-chlorite-serpentine schists and are metasomatically carbonatized in the vicinity of shear zones to light-coloured carbonate-rich and alkali-rich rocks.

Interbeds of derived proximal fine-grained to coarse-grained metasediments and mud flows display complex spatial relationships with their source calc-alkalic, tholeiitic, and komatiitic metavolcanic lithologies, and consist of feldspathic wacke, argillite, slate, arkosic conglomerate, and grey to green or pink carbonatized clastic rocks of the Upper Metasediments (*see* Table 1) which belong to the unnamed group (Jensen 1978).

The Upper Metasediments are in conformable to unconformable relationship with the metavolcanic sequences, and the entire layered sequence is intruded by variable-sized bodies of felsic to ultramafic plutonic rocks which were emplaced during two or more phases of widespread Early Precambrian alkalic plutonism.

Lower Metasediments (Pontiac Group)

In southern Rattray Township, small outcrops of metasediments protrude through an extensive and monotonous cover of Pleistocene clay and silt laid down in a shallow perched basin formed of compaction folded Coleman Member sedimentary strata. These inliers have been correlated tentatively by the author[1] with the Pontiac Group which underlies large parts of adjacent areas in Quebec (Wilson 1912, 1913; Freeman 1957; Chagnon 1968) and has also been recognized in Pense and Brethour Townships (Lovell 1977) which lie south of the current map-area.

The inliers occur as low curvilinear ridges which often parallel the foliation and are composed of quartz-feldspar-biotite-amphibole schist, feldspathic wacke, and lesser intercalated and fragmented black slaty beds. To the east, the rocks become progressively more metamorphosed and foliated in the vicinity of a wide (>1 km) gradational, and *lit-par-lit* contact zone with Early Precambrian felsic intrusive rocks; the original sedimentary stratigraphic facies is apparently continuous throughout. In areas of least metamorphism, the rocks occur as salt-and-pepper, dark to medium grey, rusty weathering, dense, medium-grained, quartzose feldspathic wackes displaying subtle stratification

[1]This correlation, though tentatively made in the text, is not made on Map 2445, back pocket.

with dips of 10 to 30 degrees) on the weathered surface. Occasional scour-and-fill structures and graded bedding occur in places along with disrupted and fragmented black slaty interbeds 5 cm to 10 cm thick. The wacke is faintly schistose and becomes increasingly recrystallized as it grades eastwards into true schist and gneiss. Microscopically, the wacke consists of angular to sub-rounded fragments of quartz, plagioclase (An_{15} to An_{25}), and minor (<5 percent) orthoclase, microcline, felsic metavolcanic fragments, and mafic minerals. Quartz occurs mainly as medium-grained sub-angular to poorly rounded fragments making up 50 to 55 percent of the rock, while vari-textured sub-angular white plagioclase (35 to 40 percent) occurs abundantly in the matrix as well as forming medium-grained, corroded, and altered clastic material disposed around quartz. Biotite, muscovite, sphene, epidote, pyrite, carbonate, apatite, and zircon occur as accessory minerals.

Eastwards with increasing metamorphic grade, the rocks assume a more foliated structure as exhibited by the development of aligned, elongated, or rodded quartz and feldspar grains, parallelism of interstitial platy minerals, and by the compositional layering which usually closely parallels original bedding. Development of alternating layers of variable thickness (0.5 cm to 1 m) is defined by concentrations of biotite- and hornblende-rich layers which alternate regularly with greater thicknesses of quartz and plagioclase-rich layers. Most of the metasediments can be classified as quartz-feldspar-biotite-amphibole schists which are completely recrystallized, light to dark grey, and medium to fine grained. Individual layers may be uniform and massive or lamellar depending on the concentration of mafic minerals along the plane of foliation. A vari-textured lepidoblastic aggregate of slightly chloritized, elongated, euhedral biotite flakes (3 to 20 percent) as well as subhedral quartz, feldspars, and blue-green amphiboles defines dark foliated micaceous layers which alternate with the generally thicker anhedral quartz- and plagioclase-rich layers. Interstitial microcline, muscovite, and zoisite also occur along with accessory sphene, apatite, zircon, pyrite, magnetite, and secondary sericite, chlorite, and epidote. Quartz also occurs in small veins, augens, and irregular pods and lenses often elongated in the foliation plane.

GRANITIZATION OF THE LOWER METASEDIMENTS

Along the southeastern boundary of the map-area, the Lower Metasediments (Pontiac Group) have been strikingly transformed and invaded by Early Precambrian (Algoman) felsic intrusive rocks and comprise border phases of a vast granitic batholith extending into Quebec (Wilson 1912; Chagnon 1968). A complex gradational contact of several kilometres width is characterized by: intricate *lit-par-lit* injection; concordant xenolithic inclusions often pervaded by numerous intersecting dikes of granite, aplite, pegmatite, and felsite; relict ghosts of assimilated schist in granite; larger mafic grain sizes and recrystallization of schist; and desilication of granite into rocks enriched in ferromagnesian minerals which grade into schist.

Within the map-area, the variable metamorphism of the Lower Metasediments has been effected without major structural deformation because the

schists retain original diagenetic planar dimensions in most areas. Diagnostic mineral assemblages are characteristic of a relatively high grade of progressive regional metamorphism within the amphibolite facies. The rocks grade eastwards into migmatites formed under high water pressures which resulted in a prevalence of hydrous silicate minerals. The original lithologies were part of a turbidite sequence derived from acid igneous terrains, and elsewhere have been interpreted as deposits laid down in a rapidly subsiding geosynclinal trough, part of more extensive and varied flysch-type sediments (Podolsky 1950).

Metavolcanics (Keewatin Type)

FELSIC METAVOLCANICS

Sparsely distributed narrow bands of rhyolitic to dacitic metavolcanics, possibly genetically related to the upper calc-alkalic cycle of the Skead Group (Jensen 1978; Ridler 1970), consist of light yellow to buff, or pink to light grey-green vari-textured massive flows, cherty tuff, tuff-breccia, and small porphyritic felsic bodies which may partly be intrusive dikes. The steeply dipping felsic metavolcanics occur as thin flows interlayered with wacke and argillite of the upper metasediments or more commonly are intercalated with mafic metavolcanics of the unnamed group.

Alloclastic to pyroclastic volcanic breccia and derived intermingled conglomerate occurring on Island CC (Photo 2), are composed of abundant (50 to 95 percent), poorly sorted, angular to rounded fragments of quartz-feldspar and rhyolite porphyries, lesser amounts of mafic to ultramafic metavolcanics, and rare sulphide clasts (2 cm to 10 cm diameter) set in a rubbly matrix of komatiitic composition which is occasionally spinifex-textured or amygdaloidal. The textures, structures, epiclastic components, marked compositional contrast between fragments and matrix, and gradual increase inland in the size of porphyry fragments into apparently intrusive bodies, suggest that pyroclastic and/or subvolcanic phreatomagmatic fragmentation of pre-existing Skead Group calc-alkaline lithologies formed these rocks. W.H. Parsons (1969) has reviewed additional detailed criteria for the recognition of volcanic breccias. Accordingly, brecciation would have resulted from resurgent juvenile magmatism marking the onset of a basal komatiitic trend in the unnamed group, but the intimately mixed conglomeratic facies represents proximal reworked subareal vent deposits. The extensive fragmentation appears to have occurred in conduits related to large volcanic centres in Skead and Bayly Townships (Hewitt 1949; F.R. Ploeger, Resource Geologist, Ontario Ministry of Natural Resources, Kirkland Lake, personal communication, 1977) to where similar lithologic features can be partly traced.

Highly altered rhyolite-dacite flows are typically massive and porphyritic with phenocrysts of quartz and feldspar (1 mm to 5 mm) set in an aphanitic often vesicular groundmass. Tuffaceous metavolcanics are usually sheared and carbonatized into carbonate rich sericite-chlorite schist and in a few places are

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Photo 2–Poorly sorted volcanic breccia on Island CC. Largest block is approximately 1 m long.

interlayered with thin (<2 m) sulfide- and graphite-bearing argillaceous cherty tuff once laid down as interflow sediments. Petrographic analysis reveals that the flows are; hypocrystalline to cryptocrystalline, seriate, fluidal to felted, hyalopilitic, occasionally microspherulitic, and devitrified. Rounded subhedral phenocrysts of corroded quartz make up 10 to 25 percent of the rock and white plagioclase phenocrysts in the composition range from An_{15} to An_{25}, constitute 10 to 35 percent of the flows. The matrix consists of quartz, plagioclase, carbonate, sericite, and chlorite usually with 1 to 2 percent disseminated pyrite, magnetite, and hematite. Tremolite, epidote, clinozoisite, chloritoid, and microcline also occur as traces in the groundmass.

Brecciated flow tops display rhomboid fragments of porphyritic rhyolite-dacite set in a tuffaceous mesh of recrystallized quartz-albite as well as sericite, calcite, and chlorite. Minor interlayerings of fine-grained pyroclastic units are typically highly altered and consist of poorly sorted, crystal to vitric cherty tuffs. These rocks consist of subhedral and fractured quartz and plagioclase (An_{15} to An_{30}), occasional felsic metavolcanic fragments set in a cryptocrystalline quartzofeldspathic matrix, and clots of calcite, sericite, saussurite, and chlorite with disseminated sulphides. Pilotaxitic and eutaxitic textures commonly occur in the tuffs which have been welded.

ULTRAMAFIC AND MAFIC METAVOLCANICS

Ultramafic Metavolcanics

Small exposures of dark green, black, or light grey ultramafic to basaltic komatiite, are commonly closely associated with magnesium-rich tholeiitic basalt, and consist of fine-grained massive and pillowed flows, pyroxenitic-textured flow interiors, serpentinite, and carbonatized rocks of variable composition. On a regional scale (Jensen 1978), the ultramafic flows occur in the basal members of the unnamed group and display intermingling and complex stratigraphic relationships with mafic and felsic metavolcanics and with the fine-grained upper metasediments. In general, the sheared and highly altered ultramafic rocks exhibit gradual transitions between ultramafic and basaltic komatiite, and are mainly distinguished in this report by the classification scheme of L.S. Jensen (1976) which is based on colour, hardness, and compositional parameters.

Soft, rusty brown weathering, pillowed flows consist of small diameter (0.2 m to 0.5 m), close-packed, rounded to ellipsoid pillows with well developed tails and recessive weathering serpentine selvages 2 cm to 5 cm thick. Calcite veins fill fractures (<2 cm thick) and light coloured varioles, approximately 5 mm in size occurring along the outer parts of the pillows, are common features. Varitextured massive flows consist of soft, dark coloured to light grey rocks with knobby rusted brown weathering surfaces. Pyroxenitic-textured flow interiors attain grain sizes of 0.2 cm to 0.5 cm, and are generally less serpentinized than finer grained parts of the flows. Randomly occurring crystalline quench structures consisting of olivine spinifex and pyroxene spinifex occur near some of the fine-grained flow contacts and are closely associated with hyaloclastic textures. In general the spinifex morphology and zonation of sheaf coarseness were not well enough developed for top determinations to be made as described by D.R. Pyke *et al.* (1973).

Petrographic analysis of these rocks indicates that in the relatively less altered flows, olivine is the major mafic component of ultramafic komatiite, while pyroxene dominates in basaltic komatiite. Subhedral olivine is commonly replaced by pseudomorphs of acicular matted flakes of antigorite altering to carbonate; abundant interstitial carbonate and epidote are also present. In the pyroxenitic flows, clotted fibrous grains of interlocking actinolized subophitic clinopyroxene constitute 75 to 85 percent of the rocks. Plagioclase is highly altered to saussurite and sericite, and 1 to 2 percent magnetite and pyrrhotite are ubiquitous accessories. Chloritic slip surfaces with abundant dark coloured talc-serpentine masses are common in the sheared ultramafic flows. Further discussion of altered ultramafic metavolcanics is given in the section "Rock Alteration and Metamorphism".

Mafic Metavolcanics

Basaltic metavolcanics ranging from high-magnesium to high-iron tholeiitic compositions make up the greatest volume of extrusive rock in the map-area, and consist mainly of fine-grained to medium-grained massive flows which are occasionally pillowed, fragmented, vesicular, variolitic, or scoriacious.

Dark green to black iron-rich tholeiitic basalt composes the lesser part of the mafic metavolcanic sequence and alternates with, or grades into greater volumes of medium grey to green magnesium-rich tholeiitic basalt and ultramafic to basaltic komatiite towards the base of the sequence.

Pyroclastic, flow brecciated, and quench fragmented phases of the lavas often occur at the tops of the successive flows, but poor exposure, structural deformation, and complex interlayering with the upper metasediments generally preclude determination of the thickness and lateral continuity of individual flows. Some of the thick massive facies of the lavas display diabasic or gabbroic texture towards the central parts of the flows.

MAGNESIUM-RICH THOLEIITIC BASALT

In the southwestern parts of Big Pete Island in Larder Lake, good exposures of magnesium-rich tholeiitic basalts display fine-grained massive flows 1 m to 5 m thick alternating with small lenses of pillow lava. Ellipsoidal pillows 0.2 m to 1 m in diameter are grey-brown with fine-grained buff to dark green variolitic selvages 1 cm to 5 cm thick (Photo 3). The massive flows are often amygdaloidal, and are separated by very irregular, well indurated dark green fragmental selvages 2 cm to 10 cm thick. Within the pillow lavas there occur small lenses of fragmented rocks including pillow breccia, flow top breccia, tuff-breccia, and hyaloclastite. Near the tops of some of the fine-grained massive flows, occurrences of quench-textured fan-shaped amphibole dendrites were used as a top determining criterion.

In thin section, the magnesium-rich tholeiitic basalts are generally aphiric, though some unevenly distributed and corroded plagioclase phenocrysts occur in the massive lavas. The less altered lavas consist of 25 to 40 percent subhedral clinopyroxene, 40 to 60 percent plagioclase laths (An_{60} to An_{70}), 1 to 3 percent disseminated magnetite plus sulphide, and a microlitic felted aggregate of longulitic minerals (micas and plagioclase) with interstitial microcrystalline to hypocrystalline material. In most places, the mafic metavolcanics have been strongly sheared or intensely altered. Deuteric effects of low grade regional metamorphism typically alter pyroxene to chlorite and fibrous amphibole, and plagioclase is mainly altered to saussurite. Secondary albite and quartz also occur.

Fragmental phases of the metavolcanics are characterized by tuffaceous to vitroclastic textured rocks composed of moderately sorted, subangular, chloritized crystallites, shards, and lithic fragments with secondary interstitial quartz and carbonate.

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Photo 3–Flow contact (along hammer handle) in magnesium-rich tholeiitic basalt between massive flow and overlying variolitic pillow lava, Big Pete Island.

IRON-RICH THOLEIITIC BASALT

In the upper levels of the tholeiitic sequence of the unnamed group, the predominating mafic metavolcanic is a dark green to black iron-rich tholeiitic basalt member typically occurring in massive flows. The rocks weather to a rough dark green or buff-brown rusty surface and display dark coloured sparkling saccharoidal fresh surfaces which are fine grained or occasionally diabasic textured. The rock is composed of: 35 to 60 percent subhedral hornblende porphyroblasts which form pseudomorphs of 0.5 mm to 1 mm sized titanaugite plates; 25 to 30 percent plagioclase (An_{40} to An_{65}) which is partly altered to quartz, albite, epidote, chlorite, sericite, and saussurite; and 5 to 10 percent titaniferous magnetite, chlorite, interstitial quartz, biotite, sphene, and carbonate. Amygdules, microvarioles, and remnant felted and fluidal textures are common. Most of these rocks are foliated to subfoliated.

In places, thin lenses of closely packed ellipsoidal pillow-lava occur interlayered with the massive flows. Thin fragmental horizons consist of a dense, rubbly, tuffaceous hyaloclastite composed of chloritized crystallitic tachylite set in a microcrystalline chloritic mesostasis.

Upper Metasediments

In the west-central part of the map-area, there are outcrops of a folded and steeply dipping metasedimentary series composed of feldspathic wacke, argillite, slate, and small amounts of lensoid interbeds of pebbly to cobbly arkosic conglomerate. Previously, these metasediments were considered to be correlatives of the Timiskaming Group (Thomson 1947, Hewitt 1949); however, recent detailed stratigraphic analysis (Jensen 1978) reveals certain complex features including widespread conformable and contemporaneous relationships in addition to the unconformable nature of these metasediments with Early Precambrian Keewatin-type metavolcanics.

The epiclastic lithologies were mainly laid down as turbidites derived from, and interbedded with, calc-alkalic, tholeiitic, and komatiitic volcanic rocks. Fine-grained, thinly stratified (5 cm to 20 cm) to massive wacke horizons predominate. Crossbedding and graded bedding with development of argillaceous or slaty parts is common.

Occasionally, interbedded with the wackes, there are small lenticular bodies (to 10 m thick) of a matrix-supported fluvialite conglomerate with a coarse arkosic matrix. Angular to well-rounded granules to boulders make up about 50 percent of the moderately to poorly sorted rock and consist mainly of mafic metavolcanics in addition to syenite, felsic porphyry, metasediment, quartz, and mafic intrusive fragments.

The fine-grained immature wackes are composed of partly recrystallized quartz, feldspar, and mafic to felsic metavolcanic fragments. The rocks are usually dark grey or buff, but are often green, grey, or pinkish where carbonatized by syenitic intrusions. Deuteric carbonate, chlorite, sericite, and amphibolite are common.

Intermediate to Ultramafic and Felsic Intrusive Rocks

Felsic to ultramafic varieties of Early Precambrian plutonic and hypabyssal rocks occur as irregular dikes, plugs, and small satellitic stocks variable in size in the west-central part of the map-area. In the southeastern part of Rattray Township, there occur complex migmatized border phases of a vast catazonal granitic batholith. The complexity of intrusive relationships with Early Precambrian metavolcanics and metasediments, unfavourable exposures, and considerable petrologic variations, pose difficulties in the classification and petrogenetic interpretation of these rocks. Felsic intrusive rocks of granitic to syenitic composition (unit 6 in Map Legend, see Map 2445, back pocket) make up the most uniform and continuous outcrop exposures. These rocks are distinguished in Table 1 from more heterogeneous and less well-exposed intermediate to ultramafic intrusive rocks having uncertain time-stratigraphic relationships (unit 5).

Pink, red, and white medium- to coarse-grained syenite and syenite porphyry closely associated with fresh pink to grey quartz-feldspar and felsite porphyries make up the most uniform intrusive varieties in the map-area (unit 6b; see Map 2445, back pocket). Lesser volumes of lamprophyre, diorite, gabbro,

and amphibolite often display intermingled and gradational relationships with syenitic rocks from which they have differentiated and are in part grouped within unit 5 (see Map Legend; Map 2445, back pocket). Light pink to red equigranular granitic rocks (unit 6a; see Map 2445, back pocket) include hornblende granite, quartz monzonite, and granodiorite, and occur in southwestern McFadden and northwestern Rattray Townships. These rocks possibly represent a more homogeneous later felsic phase of the earlier phases of intrusions which include syenite (unit 6b) and erratically distributed, but differentiated basic syenite, diorite, gabbro, and amphibolite (unit 5).

Irregular shaped plug-like bodies of coarse-grained amphibolite-pyroxenite and gabbro appear to crosscut metavolcanics in the west-central map-area and exhibit aeromagnetic response. Some of these bodies may be feeder intrusions of mafic and ultramafic volcanic rocks. Small narrow dikes (1 m to 10 m wide) and irregular bodies of late-stage biotite lamprophyre often intrude syenitic rocks, metavolcanics, and upper metasediments, and commonly result in reaction rims around assimilated xenoliths. In places, the syenitic rocks are carbonatized and invaded by quartz stringer networks with slight sulphide mineralization (pyrite, chalcopyrite).

The felsic syenite and syenite porphyries display similar mineralogies consisting of 65 to 90 percent euhedral to subhedral albite (An_3 to An_{10}), variable percentages of orthoclase, microcline, and perthite, and minor interstitial quartz. In the porphyry, frequently zoned and saussuritized phenocrysts of albite together with orthoclase occur in a fine-grained groundmass of subhedral quartz, feldspar, and varying proportions of mafic minerals, mostly biotite and hornblende. Accessory minerals include muscovite, apatite, zircon, sphene, and pyrite; secondary sericite, epidote, chlorite, and carbonate also occur. Quartz-feldspar and rhyolite porphyries consist of subhedral to euhedral phenocrysts of quartz, orthoclase, and plagioclase, mostly albite, in the range An_5 to An_{55} in a groundmass of quartz, alkali feldspar, and lesser carbonate and chlorite. Genetically related granitic rocks occurring to the south of the main syenitic intrusions are medium to coarse grained, hypidiomorphic granular, and consist of; 45 to 55 percent plagioclase (An_8 to An_{32}), 10 to 40 percent microcline, and 5 to 25 percent quartz, together with 5 to 15 percent hornblende, orthoclase, muscovite, biotite, epidote, sphene, chlorite, sericite, carbonate, rutile, zircon, and hematite. The modal composition becomes slightly more acidic towards the south.

Differentiated mafic syenite is closely related to porphyritic-textured lamprophyre dikes which are mostly of the biotite type, kersantite and minette, but the hornblende and pyroxene varieties, spessartite, and malchite also occur. Plagioclase with or without quartz and orthoclase and accessory microcline, pyrite, magnetite, rutile, sphene, apatite, and zircon usually make up the remaining primary constituents. Lamprophyre is often heavily chloritized and carbonatized with common secondary hornblende, serpentine, sericite, epidote, and leucoxene. Diopside or augite, highly altered to hornblende, occur in the groundmass as random disseminations and aggregates together with hornblende, biotite, and chlorite. Interstitial grains of seriate plagioclase (An_{20}) and occasional quartz which appears to be secondary, also make up part of the groundmass. Lamprophyre dikes in the area appear to be associated with various late stages of calc-alkaline intrusion and may not be related to a single par-

ent magma. Some may represent hybrid rocks resulting from assimilative differentiation.

Differentiated bodies, which may in part be composed of extrusive rocks, gabbro, diorite, and dark green to black, medium- to coarse-grained ultramafic rocks, appear in places to be intercalated with mafic metavolcanics. Discordant relationships, however, predominate. Plagioclase (An_{30} to An_{55}) and hornblende in varying proportions together with chlorite, biotite, sericite, carbonate, quartz, apatite, sphene, pyrite, epidote, and orthoclase in decreasing abundance, make up the constituent minerals of the gabbro-diorite. The ultramafic rocks, which in places grade into mafic intrusives, consist of varying proportions of porphyritic to ophitic-textured pyroxene and hornblende with lesser biotite, sodic plagioclase, orthoclase, magnetite, microcline, carbonate, epidote, pyrite, and sphene.

MIGMATITIC GRANITE

Southeastern Rattray Township is underlain by border phases of a predominantly concordant felsic intrusive complex which extends into Quebec to form a huge batholith referred to elsewhere as the Laurentian Granite (Wilson 1912), the Ottawa Mountain Granite-Gneiss Belt (Wilson 1956), the Southern Granite Complex (Gassow 1937), and the Oligioclase-Microcline Granite (Chagnon 1968).

White to pale grey-pink vari-textured potassic granites, predominantly monzonitic in nature, display complex migmatitic features. The rocks are often characterized by a paucity of mafic minerals and are extensively cut by aploid and pegmatoid phases. Commonly these rocks are in *lit-par-lit* contact with meta-schists of the lower metasediments (Pontiac schists) which have also undergone widespread potassic metasomatism and anatexis that have resulted in local feldspathization and transformation into massive grey paragneiss. Often these features are difficult to distinguish from the invading granites with which they have in places been grouped (see Map 2445, back pocket). A synkinematic emplacement of the granite is implied by structurally concordant features with the intruded host rocks, such as, gradational contacts, compositional layering, elongation and parallelism of plagioclase grains and xenoliths, and alignment of platy mafic minerals. The complex is unconformably overlain by Coleman paraconglomerate near the southeast shore of Icefish Lake.

The granitic rocks are massive to rarely porphyroblastic and are allotriomorphic granular to hypiodiomorphic granular. Most of the contaminated granites are uniformly homogeneous, though gneissose varieties occur in the wide granitized contact zone with the lower metasediments. Aplitic varieties are saccharoidal, but the rock is rarely equigranular, plagioclase tending to form the largest grains. Essential components are 5 to 30 percent quartz, 5 to 45 percent microcline, and 35 to 65 percent plagioclase (An_{12} to An_{16}). The accessory minerals are muscovite, biotite, chlorite, epidote, hornblende, sphene, pyrite, magnetite, and apatite.

Considerable mineralogical variations occur in response to diverse assimilative relationships in the migmatite zone. Corroded plagioclase is often re-

placed by a myrmekitic intergrowth of microcline and quartz and is commonly altered to deuteric sericite and saussurite.

A chemical analysis of granite from southeast Rattray Township (sample J165; Table 2, Chart A, back pocket) exhibits close compositional conformity with chemical data given by M. Van de Walle (1978) and Chagnon (1968) for nearby contiguous areas of the granitic intrusion in Quebec.

MIDDLE PRECAMBRIAN

Huronian Supergroup

COBALT GROUP

Gowganda Formation

COLEMAN MEMBER

More than three-quarters of the map-area are underlain by highly variable thicknesses of Coleman 'Member' sedimentary rocks which overlie the Early Precambrian basement complex with profound angular and erosional unconformity. The flat-lying to gently dipping, low grade to unmetamorphosed epiclastic series is very well exposed in prominent terraced bluffs which form north-northeast trending ridges. These are erosional remnants of extensive and thick continental deposits interpreted by the author to have been laid down in the map-area in a complex trough-like environment where glacial and periglacial conditions operated in dynamic interplay. Periodic epeirogenic tectonism combined with fluctuating climatic conditions which gave rise to attendant valley-type glaciations, created an environment of closely linked glacial, fluvioglacial, glaciolacustrine, deltaic, and subaerial associations. In this report three broad stratigraphic-type units or lithosomes are shown in the map legend under unit 7 (see Map 2445, back pocket) and have been recognized on the basis of: lithologic properties, such as sedimentary structures, detailed mineralogical and textural criteria, colour, stratigraphic continuity and dimensions; interpreted genetic associations; and generalized superposition and facies relationships. Because the Coleman Member sedimentary rocks have been laid down in a dynamically changing environment resulting in a heterogenous pattern of sedimentation, the designated units represent only generalized time-stratigraphic sequences and lithostratigraphic classifications.

In essence, the units represent spatially segregated megascale divisions, each consisting of diverse, though genetically related inter-tongued lithofacies. Such lithologic conditions are a characteristic feature of sedimentation in a dynamic transitional environment. In a strict stratigraphic sense, the properties

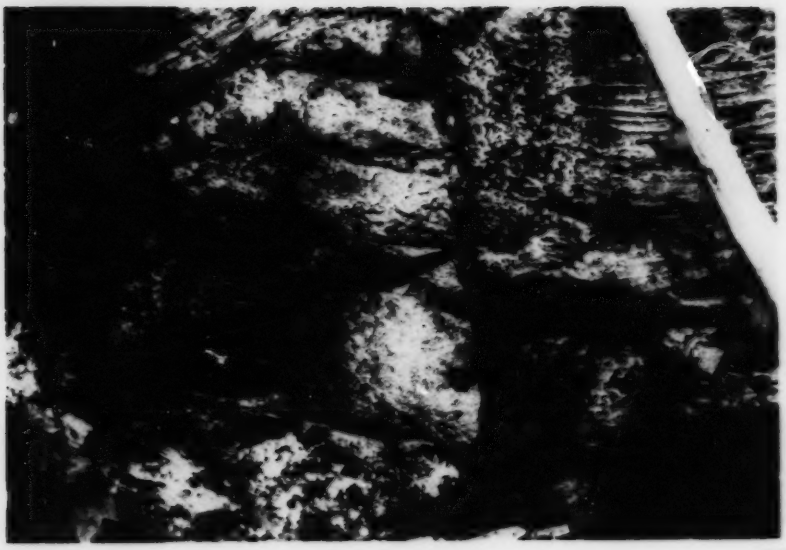
displayed by Coleman rocks of the map-area would elevate the unit to formational rather than member status, however, a more complete understanding of regional facies relationships must be developed before more definite classifications can be assigned.

Rhythmite-Turbidite Unit of Glaciofluvial-Lacustrine-Deltaic Association

The lowest exposed parts of the Coleman Member in the map-area (unit 7a on Map 2445, back pocket) are herein interpreted as an assemblage of related facies comprising periglacial outwash deposits laid down in a scoured glacial valley fiord and river system. The unit consists of inter-tongued to intergraded argillite-wacke rhythmites, subarkosic wacke turbidites, and massive arkosic wedges of probable glaciolacustrine outwash delta origin. The author suggests that variations in the general characteristics, properties and inter-relationships of these lithofacies (such as bed thickness, intercalations, structures, textures, and so on) were probably determined largely by interglacial climatic conditions, basement topography, and periodic tectonism in submountainous source areas. These factors would have infiuenced the supply, volume, distribution, and energy parameters of the various sedimentation modes.

Thinly bedded to laminated varvy rhythmite sequences of argillite-wacke represent interlayered seasonal suspension and lower flow regime bottom-current deposits in which slump-generated turbidity currents also played an important role. Rhythmites weather pale grey-green to light olive, have freshly broken surfaces that range from a dull "shaly" grey in plumose-fracturing massive to subfissile or interlaminated claystone and shale layers (from 1 mm to 2 m thick), to a sparkling blue-grey saccharoidal texture in the coarser graded sandy-silt layers interlaminated with mudstone. A narrow southwest trending band of maroon coloured rhythmite with minor grey laminae occurs at the basal part of the series south of Rattray Lake. This occurrence possibly represents an early, localized, organically-controlled, oxidizing environment in the Huronian succession (Roscoe 1973, 1969; Frarey and Roscoe 1970). Rhythmite couplet bedding typically ranges from less than 1 mm to greater than 3 cm, most of the facies are thickly and somewhat irregularly laminated. Pelitic laminae consist of indurated silt, clay, mud, rock flour, chlorite, sericite, and broken fragments of quartz, feldspar, and micas. Sandy to silty wacke laminae commonly disrupt the argillite layers and consist of convolute, lenticular, wavy, streaky, and graded layers of aligned angular quartz and feldspar fragments set in an abundant matrix of sericite, chlorite, feldspar, carbonate, epidote, clay, and opaque minerals. Random granules and small pebbles occur within the laminae.

In the upper levels of the rhythmite facies, the frequency of dropped clasts indicates that ice-rafting becomes progressively more prevalent marking a resurgent southward glacial advance. Dropped clasts are predominantly subrounded and plutonic ranging from granules to boulders 2 m across (Photo 4). Granule-sized fragments of quartz, feldspar, and argillite commonly distort and bend the rhythmite laminae; other structures include microscopic ripple-drift cross-laminations, convolute bedding, slumps, desiccation marks, and various small-scale soft-sediment deformations.



OGS 10 223

Photo 4–Large bell-shaped granite clast (2 m) disrupting rhythmite-turbidite layers.

Many of the basal parts of cliff sections in the area display repetitive interbedding of rhythmites which interdigitate on a large scale with graded subarkosic wacke turbidites. The turbidite wedges range in thickness from 2 cm to 40 cm and are commonly rusty buff to pink weathering with sparkling saccharoidal fresh surfaces which range from medium grey to purple-pink depending on the amount of argillaceous matrix. The thicker layers of this facies resemble small-scale flysch-type sequences with well-developed Bouma cycles. These rocks display a graded massive base followed by a parallel to cross-laminated cycle topped by thinly laminated mud-silt layers commonly incised by sole marks of the overlying sequence (Photo 5). Slump-generated turbidity currents from periodically over-steepened subaqueous delta fronts coupled with periodic source area uplifts were probably important agents in the genesis of these deposits. The poorly to moderately sorted wackes are generally fine grained and subarkosic consisting of rounded to angular quartz, orthoclase, and plagioclase set in a silty matrix of chlorite, sericite, epidote, pyrite, and feldspar fragments.

Components of deltaic outwash facies occur in the northern and some of the flanking parts of the area, and are represented by thick lenticular shaped bodies of coarser grained, moderately sorted, lithic to feldspathic arkose which is light grey, massive to crossbedded, and reworked. The components contain coarse fluviatile orthoconglomeratic lithologies which may possibly represent gravel bars.

OGS 10 224

Photo 5–Groove cast (parallel to handle) in Coleman wacke.

In the upper parts of the rhythmite-turbidite unit, the varvy laminated rhythmite facies dominates the section suggesting the onset of more frigid (long winters, short summers) lower energy conditions prior to ice expansion and advance. This possibly was a precursor to a second Gowganda glacial advance in the map-area which was depositional rather than erosional.

Diamictite Unit of Glacial Association

Within the Coleman rocks of the map-area, a widespread disconformity typically occurring at elevations of 245 m to 290 m a.s.l. is characterized by an undulating soled contact between the rhythmite-turbidite unit and an overlying diamictite unit (unit 7b) composed of very heterogenous massive paraconglomeratic facies. This facies locally grades into crudely stratified rocks ranging from argillite to boulder conglomerate. In most locations, the basal section of the diamictite consists of 0.5 m to 1 m of a phenoclast-rich (50 to 70 percent) graded cobbly paraconglomerate deposited possibly by torrential meltwaters of an advancing valley-glacier. Cliff exposures show successive parts of the diamictite to be made up of varying thicknesses (approximately 30 m to 100 m) of undefineable, massive, intergraded components of variably reworked tillite which displays sudden contrasts in texture, stratification, sorting, and gross structure. Great randomness of composition, size, orientation, roundness, dis-

tribution, and shape of phenoclasts suggest a dominantly passive mode of transport of a diversified load derived from varied previous erosional histories. In addition, large thicknesses without any clear-cut demarcations between successive depositions, as well as other observed textural and structural criteria, render a glacial association to be the most plausible model.

The predominating facies of the diamictite consists of poorly sorted immature, pebbly to cobbly paraconglomeratic (1 to 10 percent phenoclasts) argillaceous wacke. In outcrop, widely dispersed, angular to subangular, small to medium sized spheroidal fragments of up to twenty rock types can often be observed. Phenoclast types in decreasing order of abundance are; white porphyritic granite, granodiorite, pink granite, syenite, granite gneiss, diorite, mafic syenite, gabbro, quartz-feldspar and rhyolite porphyry, argillite, mafic metavolcanics, milky quartz, quartz-feldspar-biotite schist, red jasper, and green carbonate rock.

The phenoclast compositions indicate a widespread source area extensively composed of deeply eroded granitoid rocks with a secondary infolded metavolcanic-metasedimentary source. Phenoclasts also display weathered rims of variable thickness (0 cm to 5 cm). Phenoclast properties suggest they experienced diverse depositional histories which included a dominantly mechanical agent of physical erosion with varying degrees of chemical weathering partly dependent on climatic conditions and resedimentations.

F.J. Pettijohn and A. Bastron (1959) noted high soda-low lime contents in argillite and tillite matrix materials of the Gowganda Formation which G.M. Young (1969) attributed to low leaching and chemical alteration under frigid conditions coupled with strong mechanical segregation of iron and magnesium in fine-grained fractions. Evidence of glacial transport is well displayed by phenoclasts which can be separated from their matrix and includes grooves, plucks, striations, soled facets, rounded corners, and paired interpenetrating clasts probably developed due to the slow rate of plastic deformation in ice which would tend to hold together and grind fragments into one another.

The diamictite matrix (Photo 6) is immature, poorly sorted, blue-grey, sparkling, saccharoidal, and consists of a disrupted framework of angular to subrounded fragments of quartz, feldspar, and various broken up labile fragments dispersed in a very fine partly recrystallized aggregate of chlorite-sericite, crushed quartzofeldspathic particles, angular rock flour, and minor detrital and secondary minerals consisting of zircon, epidote, tourmaline, micas, and hornblende. A polymodal size distribution is distinctive of the matrix with the most abundant fraction being fine sand. Coarser crushed rock fragments usually make up 5 to 25 percent of the matrix and consist of various granitic, metamorphic, and sedimentary types. Petrographic classifications of matrix materials reveal great compositional heterogeneity, though most are rather quartzose (for example lithic subarkosic wacke, feldspathic lithwacke, lithic arkosic wacke).

Most of the diamictite is massive to crudely and discontinuously stratified. Extensive reworking by glaciofluvial agents and slump mudflows (Photo 7) has resulted in local intercalations of layered and more sorted facies types which include: scour channel filling composed of arkosic rocks and orthoconglomerate, and poorly sorted pebbly argillite-wacke with abundant syndepositional soft-sediment deformations, clastic dikes, ball and pillow structure, and ice-

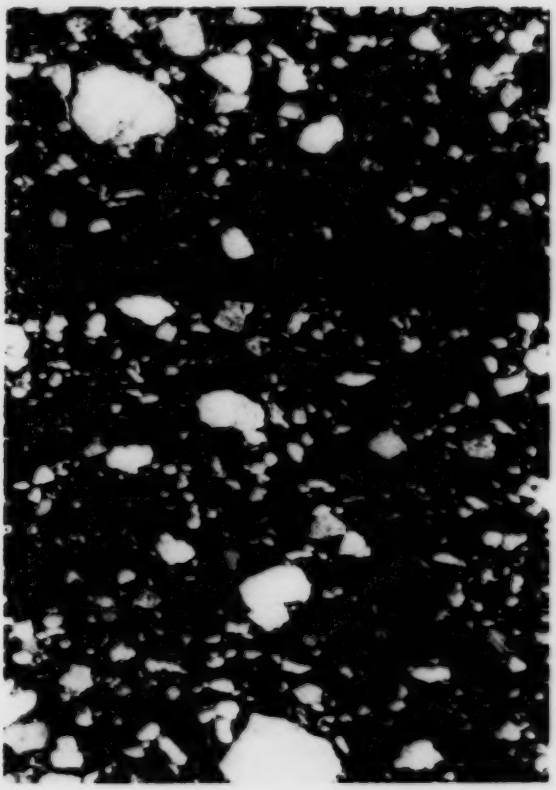


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Photo 6–Photomicrograph of diamictite matrix (x25).

thrust slumps.

In some areas, the basal contact of the diamictite is conformable and gradational suggesting low-energy subaqueous depositions of tills by lakeward advancing glaciers. The approximate locations where disconformable relations occur between the diamictite and rhythmite-turbidite units are indicated on the map (Map 2445, back pocket).

Arenite Unit of Fluvio-eolian Association

The uppermost parts of the Coleman Member (possibly lower Lorrain Formation) rocks in the area (unit 7a) are intercalated clean, mature, massive, feldspathic and quartzose arenites, flesh pink pebbly arkose conglomerate, and

OGS 10 226

Photo 7–Immature 'quick-bed' diamictite, crudely stratified by rapid hydroplastic mud-flow.

minor massive argillite. The arenites are light grey to green, moderately to well-sorted, and consist of sub-rounded grains of quartz, low-altered feldspar, and rock fragments, similar to those in the underlying diamictite, and are dispersed in a sparse matrix of sericite, chlorite, micas, clay, and iron oxides (Photo 8). Isostatic rebound following deglaciation of the sediment-filled valley probably exposed large tracts of glacial drift to meltwater fluvial and subaerial aeolian reworking. In most cases, the arenite unit grades imperceptibly into the underlying diamictite and is best recognized by its colour, texture, and massive structure. In most cases, the unit appears to be less than 20 m thick and is of irregular distribution.

LATE PRECAMBRIAN

Mafic Intrusive Rocks (Keweenawan)

A few vertical diabase dikes cut through Early and Middle Precambrian formations and are herein classified as Keweenawan. Several dikes have unexposed contacts and may be pre-Huronian. The dikes range in width from 1 m to 100 m, and generally trend east-northeast along large scale basement struc-

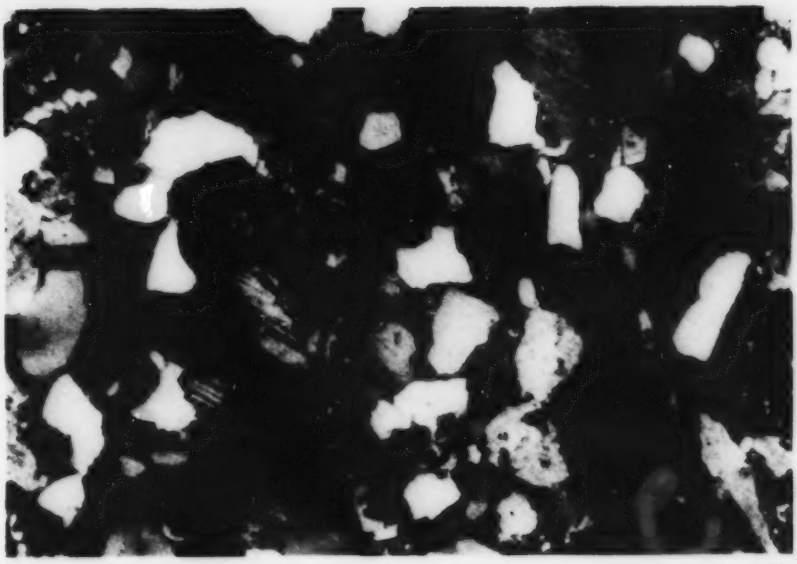

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Photo 8–Photomicrograph of submature quartzose arenite (x25).

tural elements. In Rattray Township, the diabase forms low persistent ridges and exhibits an aeromagnetic expression. Three main types are recognized in Table 1:

(1) Augite diabase is most common and contains calcic plagioclase and pale greenish brown pyroxene (augite or titanaugite);

(2) Olivine diabase is a similar related rock with 7 to 25 percent interstitial olivine;

(3) Differentiated diabase displays heterogeneous mineralogy ranging to granophyric compositions and is occasionally porphyritic; magmatically related hybrid lamprophyre is also included with this third type.

The mafic intrusive dikes are commonly medium grained, massive, fresh, dark green to rusty weathering, diabasic to gabbroic, and are weakly magnetic. Thin microcrystalline chilled-margins grade into gabbroic centres in the larger intrusions. There is little evidence of any thermal effects in the host rocks, but occasionally fragments of intruded rock are embedded in the diabase.

Petrographic analysis shows the diabase to be ophitic to subophitic, euhedral to subhedral, and occasionally porphyritic to glomeroporphyritic. Plagioclase (An_{40} to An_{65}), pyroxene (augite or titanaugite), olivine, and accessory biotite, pyrite, magnetite, ilmenite, and apatite are the main constituents. Deuteric minerals are hornblende, chlorite, epidote, calcite, sericite, and saussurite. Lath-shaped plagioclase crystals and larger irregular pyroxene grains

form a poikilitic fabric. Pyroxene also occurs as clusters of interstitial grains and is often altered to chlorite and green amphibole. Rounded grains of corroded olivine are embedded in plagioclase and pyroxene, or occur as interstitial aggregates. Olivine displays incipient alteration to serpentine and red-brown iddingsite rims. Quartz is a rare component, occurring with feldspar in micrographic intergrowths. M.F. Wilson (1912, p.46-49) described a slightly mineralized occurrence of fresh hornblende-biotite lamprophyre (camptonite) in McFadden Township which is probably a hybrid phase of the mafic intrusive dikes.

CENOZOIC

Quaternary

PLEISTOCENE AND RECENT

Detailed Quaternary mapping in McFadden and Rattray Townships has been recently conducted by C.L. Baker and D.J. Storrison (1979) and R.C.F. King and J.D. Morton (1979). Extensive deposits of Late Wisconsinan glacial drift consist mostly of a widespread basal till with a stony silty fine-grained sand matrix and clast compositions reflective of the underlying and subjacent lithologies. The average thickness of till is reported to be approximately 1 m in areas of gentle relief; but thicknesses in excess of 5 m occur in rocky highlands and in "crevasse" valleys composed of Coleman Member ridges transverse to the regional ice movement of azimuth 170 degrees (Baker and Storrison 1979). A prominent ice-contact deposit occurring in the area is the discontinuous, though well developed Boundary Esker which is defined by north-south to northeast-southwest trending low recessional ridges (usually <1 km long) composed of well to poorly sorted sands and gravels. The course of the Boundary Esker has been partly controlled by the Larder River Fault (Lovell 1974) over which a major post-glacial spillway developed (King and Morton 1979). This has resulted in extensive erosion and reworking which in some areas has resulted in distinctive deposits of well-sorted boulder veneers overlying bedrock. Small kettles occur adjacent to the esker cores. A few high narrow kames and kame terraces, usually well defined on airphotos, occur in Rattray Township to the lee of the associated Coleman Member ridges.

The most abundant Quaternary deposits in the map-area are fine-grained varved glacio-lacustrine clays and silts occurring in broad topographic depressions and low lying areas of sparse outcrop. Relatively shallower water lacustrine facies make up a more discontinuous veneer composed of modified ice-contact materials. A series of isostatic adjustments resulted in the regression of postglacial Lake Barlow-Ojibway. This accounts for the distribution and character of these lacustrine deposits (King and Morton 1979), and the eventual emergence and fluvial reworking of the Boundary Esker gravels. In poorly drained depressions over impermeable clays and bedrock, localized Recent surfi-

cial deposits of peat are developed, and alluvium is found in small streams traversing lacustrine deposits.

ROCK ALTERATION AND METAMORPHISM

Partly carbonatized Early Precambrian metavolcanics, metasediments, and intrusive rocks occur in narrow shear zones associated with the Southwest McFadden Fault in the west-central part of the map-area and are macroscopically characterized by quartz-carbonate replacements, widespread actinolite-bearing aureoles in basaltic lavas, quartz-stringer networks, and a lighter colouration and softening of the altered rock. Mafic to ultramafic metavolcanics of the komatiitic suite are often serpentinized and are most susceptible to intense carbonatization. Intense alterations occur near syenitic intrusive bodies and carbonatized lamprophyre dikes where the resultant altered compositions can be highly variable. The ultramafic carbonate rocks consist of fibro-lamellar aggregates of anhedral serpentine, massive antigorite, and cross-fiber veinlets of chrysotile. Accessory muscovite, chlorite, and iron oxides also occur. Talc-chlorite-serpentine schist and magnesium-rich carbonate are also common carbonatized phases of the komatiites. Alteration has resulted from metasomatism and involves the addition of alumina, alkalis, and volatiles (H_2O or CO_2), to the ultramafic rocks, and concomitant addition of magnesia, chromium, and nickel to the felsic intrusives, giving rise to the development of undersaturated lamprophyre and melanocratic syenite.

Regional metamorphism of the west-central belt of Early Precambrian rocks in the map-area has resulted in metamorphic assemblages which range from the subgreenschist to lower greenschist facies and represent at least two separate phases of metamorphism. Pumpellyite, epidote, and chlorite occur within the volcanic rocks and are most likely representatives of an earlier facies of low temperature metamorphism developed during a phase of increased geothermal gradients within a deeply buried lava pile. Towards the west, patchy development of crudely foliated lower greenschist facies assemblages has overprinted the pumpellyite-bearing rocks. The resultant dominant secondary phases: chlorite, epidote, albite, actinolite, biotite, and stilpnomelane were developed within a broad aureole of the Round Lake Batholith which outcrops approximately 20 km to the west.

Middle Precambrian Huronian strata in the map-area are for the most part undeformed epiclastic sedimentary rocks. K.D. Card (1978) has recognized a general pattern of regional metamorphism in Middle Precambrian supracrustal rocks related to variation in thickness and lithologic facies, intensity and style of deformation, and felsic plutonic activity. These criteria are genetically related to low pressure intermediate type subcrustal processes of the Penokean Orogeny (1900 my ago) which were localized along major structural discontinuities in the Southern Province. Alteration of Middle Precambrian rocks took place under subgreenschist facies conditions ranging from diagenetic to epigenetic zones. The Coleman sedimentary rocks in the map-area are for the most part unmetamorphosed, but locally contain metacrysts of chlorite, muscovite, and pyrite, also some of the coarser quartzofeldspathic arenites have been re

crystallized. In general, the rocks consist of mixtures of original detrital minerals, diagenetic minerals, and epigenetic minerals. Card (1978) listed the following diagnostic assemblages of the subgreenschist facies for rock types occurring in the Huronian, but considerable difficulties arise in the assignment of particular assemblages to the various categories and in distinguishing between diagenetic and epigenetic minerals.

Mineral assemblages for sandstones, including alumino silicate-bearing sandstone are:

Quartz-kaolinite, quartz-diaspore, quartz-pyrophyllite-sericite, quartz-hydromicas, quartz-muscovite (paragonite)-albite.

For argillaceous rocks the mineral assemblages are:

Quartz-kaolinite, quartz-(illite-montmorillonite), quartz-pyrophyllite-muscovite (paragonite), quartz-muscovite (paragonite)-chlorite-albite, quartz-stilpnomelane.

ROCK GEOCHEMISTRY

Fifty-six hand specimens from the map-area were analysed by the Geoscience Laboratories, Ontario Geological Survey, for major oxide and selected trace element compositions. Table 2 (Chart A, back pocket) summarizes the geochemical data and lists sample locations and rock names according to the classification scheme of Jensen (1976) for the volcanic samples. Sample locations are also indicated on the geologic map (Map 2445, back pocket).

Twenty analyses of volcanic rocks have been plotted on the AFM diagram (Figure 2, after Irvine and Baragar 1971) and on the Jensen cation plots (Figure 3) after (Jensen 1976), and indicate that the subalkalic rocks of the area fall into the calc-alkalic, tholeiitic, and komatiitic fields. The compositional trends and chemical affinities displayed by the volcanic sequences reveal two components of penecontemporaneous petrogenetic cycles. Regionally, these cycles have been recognized by Jensen (1978) as members of mappable formations composing a series of major volcanic cycles in the Kirkland-Larder Lakes area. In the current map-area, felsic metavolcanics and probably some mafic metavolcanics represent waning consanguineous volcanism of a calc-alkaline cycle referred to as the Skead Group (Jensen 1978), but the ultramafic to mafic metavolcanics of a commencing komatiitic trend belong to the basal members of an extensive unnamed group which appears to become more tholeiitic to the northeast across the map-area.

STRUCTURAL GEOLOGY AND PALEOGEOGRAPHY

Layered metamorphic assemblages of the Early Precambrian complex in the west-central part of the map-area show structural correspondence with a large arcuate fold belt, the fold axes of which are convex to the east extending into Hearst, Skead, Bayly, and McVittie Townships, and compose the hinge area of a large eastward plunging synclinorium (Jensen 1978). Vertical to

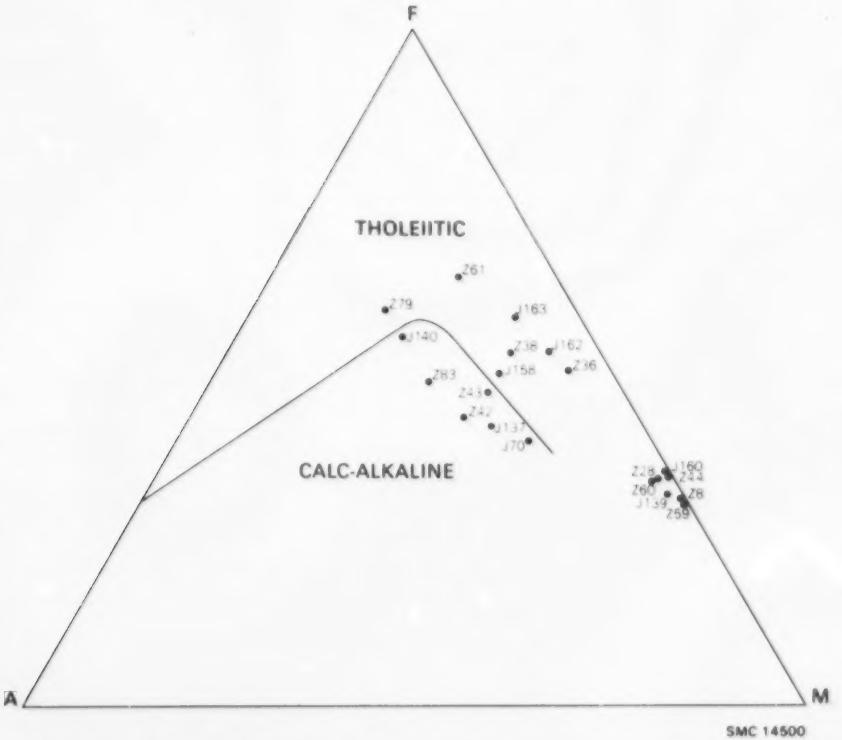

Figure 2–AFM plot of 20 analyses of metavolcanics from the map-area, after the classification of Irvine and Baragar (1971).

steeply dipping lava flows generally strike north; several phases of tight folding, numerous faults, and contact zones with intrusive bodies, however, give rise to local variations. Less competent intercalated to unconformable metasediments display even greater structural complexity creating difficulties in determination of their stratigraphic relationships.

Prominent faulting and major lineaments in the area occur in two main trends; north to northeast and northwest, and the latter group, the Late Timiskaming Rift System, (Lovell and Caine 1970) offsetting the older north-northeastward trending faults, and the former being more prominent in effecting strike displacement, shear, schistosity, jointing, and fault-scarp formation. J.E. Thomson (1947) and Hewitt (1949) described major folds and faults in adjacent townships to the west and presented structural cross-sections. A major lineament designated the Larder River Fault in Bayly Township (Lovell 1974) extends along the northeast-trending water course into the map-area and has produced vertical offsets and facies variations in Coleman Member sedimen-

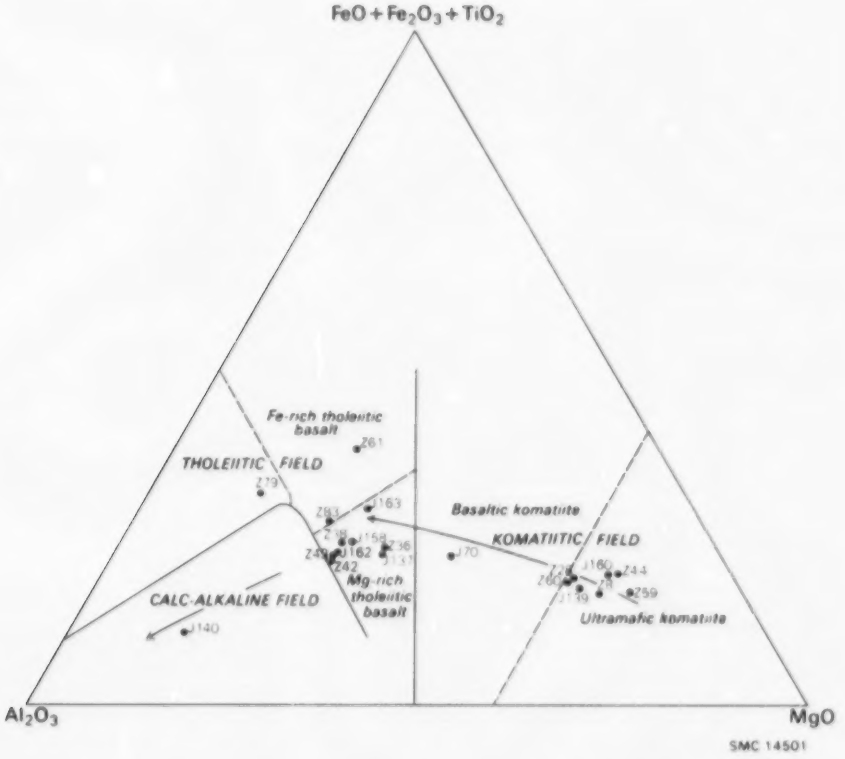

Figure 3–Jensen cation plot (after Jensen 1976) of twenty chemical analyses of metavolcanics from the map-area showing compositional trends of volcanism.

tary rocks. Conjugate jointing is widespread in Coleman rocks and is well displayed on both outcrop and map scales. In proximity to faults intraformational breccias (Photo 9), slickensides, and paleo-talus deposits are often observable.

The major structural element which controlled deposition of the Middle Precambrian Coleman rocks is an elongate depression. This depression first appeared as a system of down-faulted blocks in the underlying Archean complex; it extends northwards from the Cobalt Embayment to the Larder Lake-Cadillac Break where the trend changes eastward into Quebec as the Cobalt rocks of the Kekeko Hills. The depression, referred to by the author as the Larder Lake Trough, is interpreted to have been a large fiord-like rift valley (intermontane trough) bounded by a system of steeply inclined faults which underwent periodic displacements throughout the Middle Precambrian. This trough adjoined, directed large quantities of detritus to, and was tectonically affected by a large actively subsiding basin to the south (Cobalt Embayment). Within the trough,

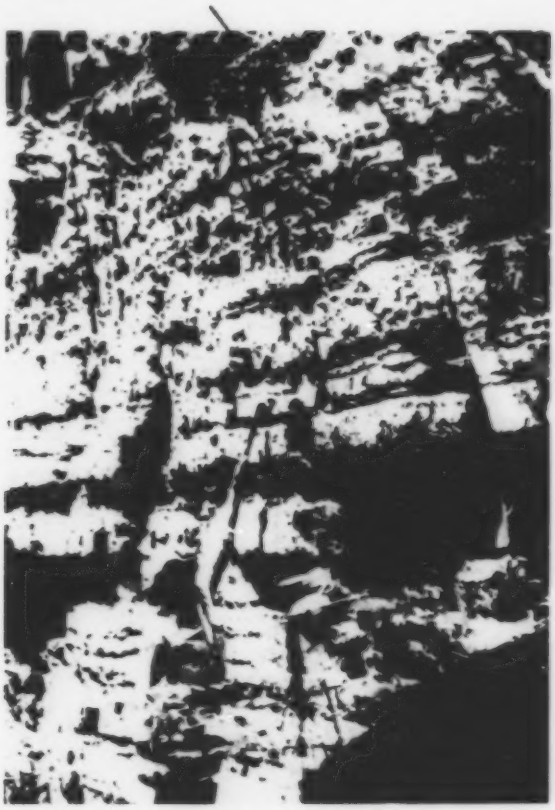

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Photo 9–Rhythmite-turbidite sequence overlain by intraformational breccia above tip of handle.

sedimentation, namely thickness and facies changes, intraformational erosion, and so on, was strongly influenced by epeirogenic crustal tectonism approximately from 2.4 Ga to 2.2 Ga. The author considers that basement warping between source area uplifts to the north and a subsiding geosynclinal area to the south, caused tensional strain and block-faulting along pre-existing structural weaknesses in the marginal area. Periodic adjustments along these steep-sided faults have caused syndepositional deformation structures, flexures in overlying strata, and upward extensions of basement faults through Coleman Member sedimentary rocks. General dips, facies distributions, pebble fabrics, and paleocurrent directions, reveal a dominant southwesterly (195 degrees) transport with secondary southeasterly directions from tributary paleovalleys west of the map-area.

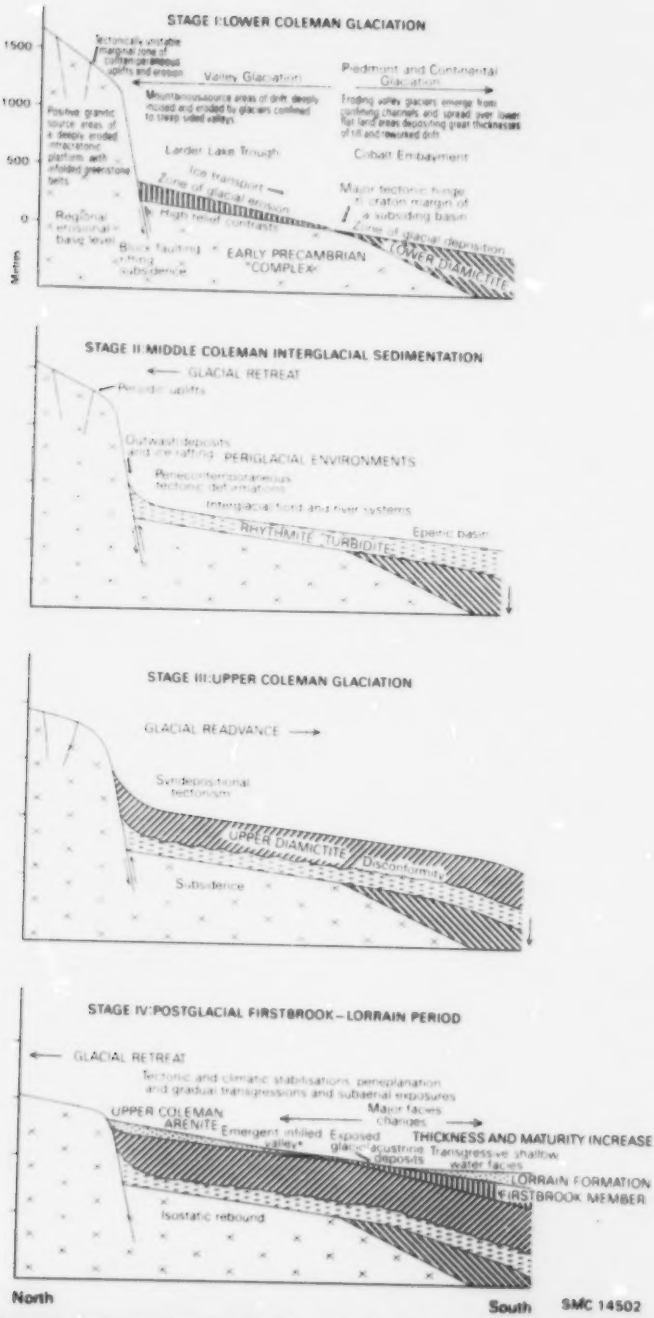

Figure 4–Schematic representation of Middle Precambrian tectonic facies evolution in the Larder Lake-Cobalt Region. North is to the left and south to the right of the section.

As previously stated, the Coleman Member of the map-area represents a unique hinterland facies of the Gowganda Formation. Young (1973) explained facies relationships between the Gowganda Formation and the underlying Serpent Formation of the Huronian in terms of a migrating facies model in which contemporaneous glacial erosion in the north accompanied deposition in the south. In the vicinity of Cobalt to the south of the current map-area, R. Thomson (1957) recognized a two-fold subdivision of the Gowganda Formation based on genetic criteria. The lower unit (Coleman Member) consists of heterogeneous conglomerates often with intervening or interlayered horizons of thinly bedded grey-green slate-like greywacke and crossbedded quartzite, and an upper thick unit (Firstbrook Member) made up of reddish tinged well-bedded (0.1 mm to 5 mm) argillites which often display couplet bedding (Thomson 1978). A simplified tectonic-facies model is presented in Figure 4, an attempt to account for the major regional lithofacies relationships.

A definite contact of the Coleman Member with the underlying Early Precambrian assemblages is not exposed in the map-area because Archean block-faulting, which controlled sedimentation, is very steep, often drift-covered, submerged, or covered by upper units of the Coleman Member. Variations in the gentle dips of the unfolded Coleman strata faintly reflect the topography of the rugged basement over which they have been draped and supratenuous compaction during diagenesis of thick sediments on the flanks of the subsiding trough has produced a gentle primary synclinal structure. Diamond-drill data within the Larder Lake Trough (J.E. Thomson 1957, 1941; Ambrose and Ferguson 1945; Assessment file data from Kirkland Lake Resident Geologist's office) reveal that the sub-Coleman valley had relief in excess of 1500 m, was underlain by fault zones, produced steeply dipping unconformities in Coleman strata along its flanks, and accumulated thicknesses possibly in excess of 1000 m which is the probable present thickness in the deepest parts of the trough. In the Bourkes area northwest of Kirkland Lake, H.L. Lovell (1971) considered lithologic features of Cobalt sedimentary rocks to be representative of yet another paleotrough transitional environment and it is likely that other similar features will be recognized as the northern parts of the Southern Province are studied in detail.

ECONOMIC GEOLOGY

The map-area is a relatively unexplored area situated in the vicinity of a well established gold mining camp, and is considered to be of economic interest and worthy of further mineral exploration. Possible development of mineral commodities is excellently facilitated by conditions of access, transportation, communications, energy, and current exploration activities in the region (Lovell and Ploeger 1978).

McFadden and Rattray Townships are situated immediately south of McGarry Township (*see* Thomson 1941) where the Kerr Addison gold mine occurs. This mine is hosted in favourable carbonatized rocks of the Larder Lake-Cadillac Fault. Despite this proximity to the Kirkland-Larder Lakes gold belt, the map-area has not been adequately or extensively investigated by recently

developed concepts and methodologies of mineral exploration. Likewise, scant records of early mining exploration and prospecting activities indicate only small scale programmes consisting of exploration drilling and shallow trenching.

The paucity of exploration work in these townships is largely a consequence of the geologic conditions. More than three-quarters of the map-area is underlain by a considerable thickness of rugged, ridge-forming, Cobalt group sedimentary rocks. These were found to be barren of near-surface mineralization by widespread prospecting activities generated by the Cobalt and Larder Lake silver and gold rushes from 1903 to 1906. In addition, trace element assays and careful examination by the author of numerous replacement-type milky quartz-vein systems which erratically pervade Cobalt group rocks failed to reveal any significant mineralization other than pyrite and occasional traces of chalcopyrite. It is, however, possible, given favourable conditions of geochemical gradients and auriferous source rocks nearby, that some of the more continuous, and deep fault-controlled fissure-filling veins have tapped precious metal sources, and are mineralized at depth.

Exploration work for which records are available is summarized in the section on "Description of Properties" and indicates that surveys have been concentrated over a zone a few kilometres wide which occurs in the western parts of the townships. This area of current interest, extending into Hearst and Skead Townships, comprises part of a complexly folded and faulted Early Precambrian metavolcanic-metasedimentary sequence intruded by variable sized bodies of Algoman-type granitic and syenitic rocks. Certain lithologic and structural conditions within this arcuate fold belt fulfill some of the following criteria which have been found to be amenable to gold and base-metal mineralization in the Kirkland-Larder Lakes camp:

1) Sulphide fragments such as those which occur in volcanic breccia on "Island CC" have elsewhere in the region been associated with numerous showings of massive to disseminated chalcopyrite, molybdenite, sphalerite, pyrite, and minor gold within the Skead Group (Jensen 1978).

2) Carbonatized and syenitized metamorphic rocks of the unnamed group display genetic affinities with similar altered gold-bearing rocks at the Kerr Addison Mine.

3) A few narrow sulphide-bearing cherty-tuff horizons (interflow sediments) occur randomly distributed within the metavolcanic sequences (eg. Big Pete Island and "Island CC") and are regionally associated with numerous occurrences of lead-zinc and minor chalcopyrite mineralization in graphitic layers, and are also important host rocks for auriferous pyrite at the Kerr-Addison Mine.

4) Alkalic syenite intrusions with slight sulphide mineralization consisting of pyrite and chalcopyrite occur in the area, and elsewhere appear to have been responsible for concentration of gold and silver (Thomson 1948). W.J. Wolfe (1976) discussed the importance of gold concentration in Precambrian felsic plutonic rocks as an indicator of mineralization in adjacent intruded rocks (for example the Larder Lake Stock) and described geochemical techniques. Pink hornblende granite occurring in McFadden Township was described by Hopkins

(1924, p.7) as being similar to gold-bearing granite occurring 3 km to the southwest in Skead Township. Results of a very limited sampling and analysis in this study indicate slightly anomalous gold values.

5) Deep-seated rift-faults occurring as subsidiary branches of the Larder Lake-Cadillac Fault may have localized hypogene ore concentrations (Savage 1964; Kutina 1972). Milky Creek, Northeast Arm-Benson Creek, and Southwest McFadden Faults (Thomson 1947) are all probable transecting faults of the main Larder Lake-Cadillac Fault.

W.S. Savage (1964) and R.H. Ridler (1970) have described various gold ore types occurring in the Kirkland-Larder Lakes camp. H.L. Lovell and F.R. Ploeger (1978) have summarized salient considerations which bear on the search for economic gold deposits of various types. Lithologic conditions in the vicinity of Island CC, which appear to be related to an Early Precambrian volcanic conduit, are appropriate for the possible occurrence of volcanogenic massive sulphide mineralization. A few small, steeply dipping zones of graphitic sulphide-bearing (pyrite, minor pyrrhotite, chalcopryite) intrastratal cherty-tuff occur within the massive to pillowform flows on Island CC and Big Pete and within the metavolcanic complex to the south; however, previous exploration has not detected any significant mineralization. There is also the possibility of economic gold or massive sulphide mineralization in Early Precambrian rocks which underlie the Coleman rocks of the Larder Lake trough. The areal extent and highly variable thickness of the Coleman Member necessitates the use in detail of deep-probing geophysical methods to locate favourable shallow conductors for diamond-drill follow-up to obtain stratigraphic, structural, and assay data. Local prospectors have reported small inliers of mineralized Archean rocks in Milky Creek valley and west of Raven Falls, but the exact locations of these unverified occurrences are unknown.

In the Cobalt mining camp, the Coleman Member has been found to be an important host for native silver and Co-Ni arsenide veins. The current map-area appears to be unfavourable for the occurrence of Ag-Co-Ni mineralization due to the apparent absence of the Nipissing Diabase which displays an intimate association with the mineralization at Cobalt.

Occurrences of radioactive oligomictic conglomerate beneath Gowganda Formation paraconglomerate in the Timagami Lake area (Roscoe 1969) and uranium showings in wacke, conglomerate, and trachyte in the Kirkland-Larder Lakes area (Lovell 1968) suggest possible paragenetic affinities with the tillite-bearing Witwatersrand succession in South Africa which hosts important gold-uranium placer concentrations (Pretorius 1974). Basal Coleman conglomerates situated short distances down transport direction from Early Precambrian gold deposits and uraniferous granitic terrains along the Larder Lake Fault, might be possible repositories of Rand type gold-uranium placer deposits. The unfavourable characteristics of exposed Coleman Member lithologies with respect to placer gold uranium deposition are; lack of sorting, and textural and compositional immaturity. These characteristics, the maturity indices, are important requisites for the genesis of this ore type, but more favourable lithologies may occur in the unexposed basal parts of the Coleman sequence which directly overlie the Early Precambrian complex. Reconnaissance radiometric surveying, using a gamma-ray spectrometer McPhar TV-1A, failed to detect any significant anomalies, however, count rates in excess of

twice the uranium background were recorded over drab-coloured gritty feldspathic wacke units in the lower horizons of the exposed Coleman Member.

Occurrences of pyrope garnets and chrome diopside in Pleistocene glacial tills of the Kirkland-Larder Lakes area (Lovell 1968) indicate possible derivation from kimberlite (Ferguson and Freeman 1978, p.191-196). This alkaline intrusive rock type occasionally hosts diamonds and can be the source of alluvial placer diamond concentrations. Kimberlite dikes outcrop near Larder Lake, this raises the possibility of diamondiferous occurrences within the map-area.

Descriptions of Properties

Properties shown on the Map 2445, back pocket, are described here under the names of the most recent property holders. The number in parentheses following the holder's name is the property location number on the Map 2445, back pocket. Table 3 gives additional information on previous holders and details of exploration work. Figure 5 indicates the location of current and cancelled claims in the map-area.

COLEX EXPLORATIONS INCORPORATED (1)

The Colex property in McFadden Township comprises 24 claims. The claims make up part of a claim group extending west into Hearst Township, and includes the two large islands at the southeast end of Larder Lake and adjacent lake areas. Incomplete mineral exploration records show that the islands have been previously investigated between 1947 and 1952, and in 1968 (see Table 3) by at least 24 diamond-drill holes (totalling 1694 m in length) and several trenching operations, the sites of which were observed by the field party. In 1977, Colex Explorations Incorporated undertook airborne geophysical surveys, and survey lines were cut on both islands to facilitate ground geophysics, geochemistry, and detailed mapping (Table 3). The property is mostly underlain by Early Precambrian metavolcanics and appears to coincide with a paleotopographic high or dome with an anticlinal axis trending north to northwest through Big Pete Island.

Big Pete Island is underlain largely by a sequence of predominating magnesium-rich tholeiitic basalt flows, ultramafic to basaltic komatiite, and a few narrow north-trending bands of felsic metavolcanics and cherty tuffs. At the eastern extremity of the island as indicated on Map 2445 (back pocket) a 1 m to 2 m wide zone (length unknown) of graphite-pyrite-pyrrhotite and minor galena sphalerite-bearing intrastratal cherty tuff is exposed by trenching and has a strike orientation of N60°E and dips 85°N. The site was drilled in 1951-52 by E. Lipasti (Table 3) who detected weak Pb-Zn mineralization at depths of less than 20 m. Other small occurrences of sulphide-bearing interflow sediments are found within the felsic metavolcanic bands and most have been trenched exposing moderate to heavy pyrite mineralization. Trenches and pits within

TABLE 3 | LIST OF PROPERTIES FOR McFADDEN AND RATTRAY TOWNSHIPS.

RECORDED HOLDER	FILE*	DATE	TYPE OF WORK	DESCRIPTION
CURRENT PROPERTIES: McFADDEN TOWNSHIP				
1. Colex Explorations Inc., MacGregor Group 3	2.2446, 2.2697, 63.3507 & Kirkland Lake**	1977	Airborne & ground EM, MAG; Soil geochemistry (Cu, Ni, Zn)	Exploration for massive sulfides; weakly anomalous Cu in soil (to 375 ppm) detected on Big Pete Is. along with high Zn in soil (1677 ppm); several EM conductors detected.
Previous Work:				
1a. (Lipasti, E.)	Kirkland Lake	1951, 1952, 1968	Diamond drilling	Exploratory drilling for massive sulfides; total of 17 holes (aggregate length 300 m); weak Pb-Zn mineralization in pyrite-graphite bearing felsic to mafic metavolcanics on east end of Big Pete Is.
1b. (Lucky Girl Mines Ltd., Avery Group)	Kirkland Lake	1947?	Diamond drilling	Exploratory drilling for gold; four holes (approx. 600 m) put down at south and west ends of Is. CC and single holes on the south and east shores of Larder L., 5.7 g/t Au intersected at the south end of Is. CC.
1c. (Wojcieszyn, P.)	Kirkland Lake	1948	Diamond drilling	Exploratory drilling for gold; four holes (930 m) at west end of Is. CC intersected sequence of mafic to ultramafic metavolcanics, felsic intrusives, lamprophyre, and minor felsic metavolcanics; some unspecified mineralization detected.
2. Lacasse, L. MacGregor Group F1 (Selco option)	2.2292 & Kirkland Lake	1977	Airborne MAG, EM	Exploration for massive sulfides (Cu, Zn); high magnetic relief over a complex fold-belt of mafic and ultramafic metavolcanics with narrow bands of felsic metavolcanics and stocks of syenite-granite.

RATTRAY TOWNSHIP					
2.	Lacasse, L. MacGregor 'Rattray' Group (Selco option)	2.2292, 2.2508, 63.3455 & Kirkland Lake	1976, 1977	Airborne and ground MAG, EM	Exploration for massive sulfides (Cu, Zn); a few small sized conductors of narrow width and coincident EM response were detected.
CANCELLED PROPERTIES:					
	McFADDEN TOWNSHIP				
3.	Geophysical Engineering Ltd.	2.2142 & Kirkland Lake	1976	Airborne MAG, EM	Exploration for massive sulfides (Cu, Zn); a few medium to short length bedrock conductors were located; no follow-up.
	RATTRAY TOWNSHIP				
4.	Mathias Occurrence (Kerr Addison option)	10 & Kirkland Lake	1956	Diamond drilling	Exploratory drilling over a Cu occurrence in the SW of Icefish Lk; six holes (459 m) detected traces of Cu mineralization in pyritiferous quartz veins cutting Coleman conglomerate and Pontiac schist intruded by porphyritic Algoman granite; best assay-Cu 0.26%, Au Tr, Ag 0.07%.

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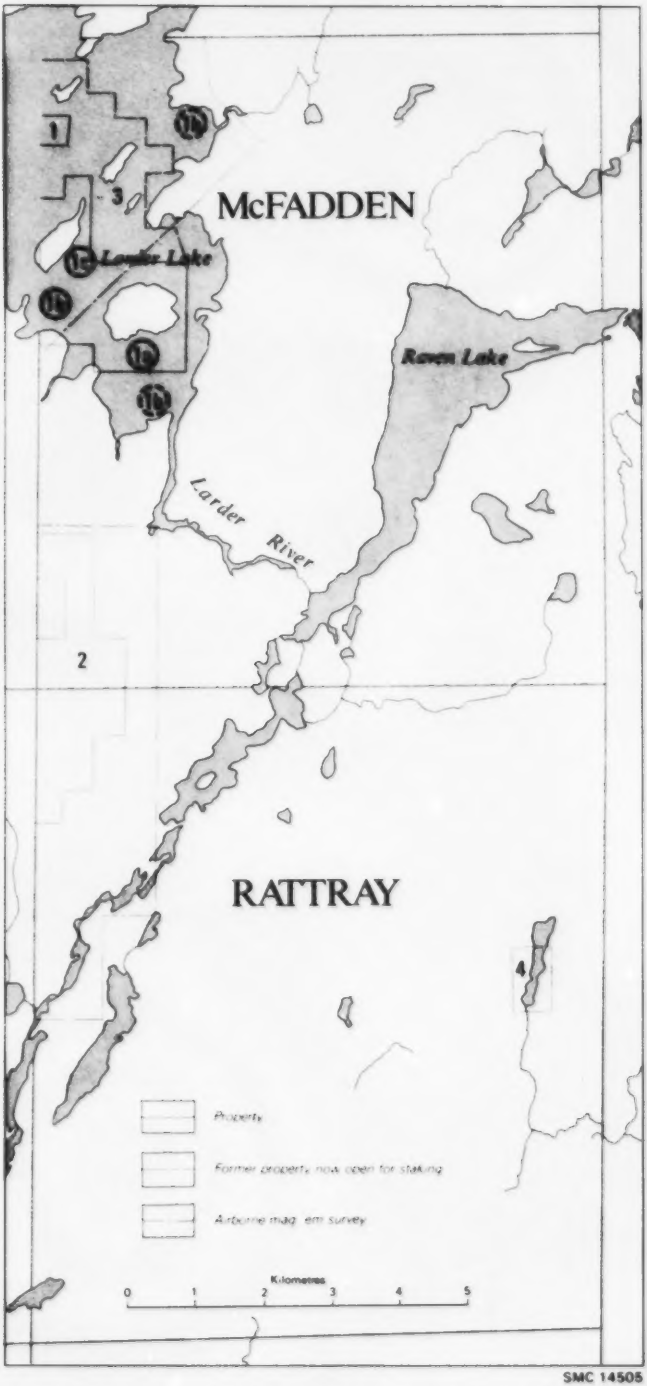

Figure 5–Property location map for McFadden and Rattray Townships. See Table 3 for data on properties 1a, 1b, and 1c.

the mafic metavolcanics are mostly barren of mineralization except for a small pyrite-chalcopyrite-bearing quartz-feldspar vein cutting pillow basalt in the east-central part of the island.

Island CC is underlain by a distinctive coarse alloclastic volcanic breccia intimately mixed with derived poorly sorted conglomerate and a few thin ultramafic flows. The breccia is cut by lamprophyre and small intrusive bodies and dikes of feldspar porphyry. Small narrow (<2 m wide) bands of minor sulphide-bearing interflow rock occur within a few randomly distributed cherty tuff lenses and rare cobble-size fragments of rusty sulphides were observed in the volcanic breccia. Lucky Girl Mines Limited drilled four sites on the island in 1947 (see Table 3) and is reported by Geophysical Engineering Limited (File 2.2142, Assessment Files Research Office, Ontario Geological Survey, Toronto) to have intersected 5.7 grammes per tonne of gold over a length of 1.5 m at the south end of the island. Eight diamond-drill holes were also put down by this company at the south end of Larder Lake and near the mouth of Milky Creek (Figure 4). Exploratory drilling for gold was also performed by P. Wojcieszyn in 1948 at the west end of Island CC (see Table 3). Core log data for some of the drilling done on the Colex property is filed in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Kirkland Lake, but most of the core itself has been disposed of or removed to unknown locations.

GEOPHYSICAL ENGINEERING LIMITED [1976] (2)

In 1976, Geophysical Engineering Limited held a property north of the Colex claim group which included water covered areas in the vicinity of the Milky Creek Fault and a few small islands underlain by Coleman sedimentary rocks (Figure 5). Airborne and ground magnetometer and electromagnetic surveys in the vicinity of the fault detected small narrow conductors, but no follow-up was initiated, and the claims were allowed to lapse.

L. LACASSE (3) and (4)

The Lacasse property is situated in the west-central part of the map-area with 23 unsurveyed claims occurring in McFadden and Rattray Townships. The terrain is densely forested, low-lying, and largely drift covered. An Early Precambrian sequence of mafic tholeiitic metavolcanics with narrow north-trending felsic metavolcanic bands is overlain and intercalated with Early Precambrian turbidite metasediments which are mostly fine grained. The metamorphic complex is intruded by lamprophyre, gabbro, syenite, and granite. The rocks have been strongly carbonatized by calc-alkaline felsic intrusives and the area has been subjected to several phases of complex folding and faulting. Scant information is available on this favourable though little explored area. Airborne and ground geophysical surveys undertaken in 1976 and 1977 (see Table 3) suggest the presence of a few narrow conducting zones of sulphide mineralization. The property was in good standing as of December 31, 1978, but no further work has been reported.

MATHIAS OCCURRENCE (5)

Two cancelled claims at the south end of Icefish Lake in Rattray Township (Figure 4) make up the Mathias property on which a small copper occurrence is located. Pyrite-chalcopyrite mineralization occurs in randomly oriented 1 cm to 10 cm wide quartz veins cutting Coleman paraconglomerate and Pontiac schist (lower metasediments) on the southwest shore and below the water level of Icefish Lake. Six exploratory diamond-drill holes (totalling 459 m in length) were put down by Kerr Addison Mines Limited in 1956. The best assay reported 0.26 percent Cu over a length of 0.3 m and also detected were silver (0.07 percent) and traces of gold. The unclaimed occurrence lies near the contacts between Coleman rocks, Early Precambrian Pontiac schist, Early Precambrian granite, and an eastward trending differentiated Late Precambrian diabase dike.

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